



*Intelligence Community Forum*

*November 5, 2008*

*Washington, DC*

Onsite Agenda

**National Intelligence Perspective**

Dr. Pete Rustan, Director, Ground Enterprise Integration Office, NRO

**USD(I) DOD Perspective**

Mr. Bob Arbetter, Director for Collection Concepts and Strategies, OUSD(I)

**IARPA Vision and Focus**

Dr. Lisa Porter, Director, Intelligence Advanced Research Project Agency, ODNI

**Operational Neuroscience**

Dr. Amy Kruse, Program Manager, Cognitive Science, DARPA Defense Sciences Office

**Warfighter Perspective**

Mr. James "Snake" Clark, SES, Director ISR Innovations and UAS Task Force, HQ USAF A2

**Chief Scientist Panel: S&T Solutions of Interest**

**Panelists:**

- Dr. Eric Kaufman, Chief Scientist, National Counter Terrorism Center
- Mr. Michael Gilbert, Technical Executive, Innovision Directorate, NGA

**Acquisition and Intelligence Community Collaboration**

Ms. Kristen Baldwin, Acting Director, Systems and Software Engineering, ODUSD(A&T)

# INTELLIGENCE COMMUNITY FORUM

*IC Interest Areas to Focus Industry's IRAD*

## SESSIONS INCLUDE:

- ▶ National Intelligence Perspective
- ▶ USD(I) DoD Perspective
- ▶ IARPA Vision and Focus
- ▶ Defense Science Board Task Force:  
Operations Research in Support of ISR
- ▶ Warfighter Perspective
- ▶ Chief Scientist Panel:  
S&T Needs and Solutions of Interest
- ▶ Acquisition and Intelligence  
Community Collaboration

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THE C4ISR DIVISION OF  
NDIA & USGIF**



**NOVEMBER 5, 2008**

**[WWW.NDIA.ORG/MEETINGS/9760](http://WWW.NDIA.ORG/MEETINGS/9760)**

**BOLLING AIR FORCE BASE ▶ WASHINGTON, DC**

**EVENT #9760**

## INTELLIGENCE COMMUNITY FORUM

NOVEMBER 5, 2008 ► BOLLING AIR FORCE BASE

### Background:

Recent cross-agency intelligence organization initiatives have advanced and challenged the capability gaps in collecting intelligence, analyzing it and sharing it. Incremental improvements while notable cause chaos in reaching agreement as well as consensus as to the proficient leveraging of government investment initiatives along with industry's IRAD focus areas. To be sure, the goal of understanding the areas of IC capability needs is the first step towards the maturation of technology essential for the enhancement of system solutions for fusion into the intelligence community family of professional tools and products.

### Conference Objectives:

This forum will enable the interchange of ideas amongst government and industry Program Analysts, Portfolio Managers, Systems Engineers, Chief Scientists, Researchers and Product Engineers who are subject matter experts in specific areas of intelligence related science, technology and application domains. Historically the US Industrial Base has responded to the clarion call when called upon. In the period of constrained and limited discretionary resources, it is imperative that the industrial community deliver solutions whose capability not only satisfy the IC operational capability needs but also effect the operational tactics, techniques and methods of employment essential to the mission.

6:30 a.m.      **Registration and Continental Breakfast**

7:45 a.m.      **Welcome Remarks and Introductions**

Mr. Sam Campagna, Director, Operations, NDIA;  
Dr. Steve Kimmel, NDIA C4ISR Division Chairman;  
Senior Vice President for Corporate Development

8:00 a.m.      **National Intelligence Perspective**

Dr. Pete Rustan  
Director, Ground Enterprise Integration Office, NRO

8:30 a.m.      **USD(I) DOD Perspective**

Mr. Bob Arbetter  
Director for Collection Concepts and Strategies, OUSD(I)

- 9:00 a.m.      **IARPA Vision and Focus**  
Dr. Lisa Porter  
Director, Intelligence Advanced Research Project Agency, ODNI
- 9:30 a.m.      **Break**
- 10:00 a.m.      **Operational Neuroscience**  
Dr. Amy Kruse  
Program Manager, Cognitive Science, DARPA Defense Sciences Office
- 10:30 a.m.      **Warfighter Perspective**  
Mr. James “Snake” Clark  
SES, Director ISR Innovations and UAS Task Force, HQ USAF A2
- 11:00 a.m.      **Lunch**
- 12:00 p.m.      **Chief Scientist Panel: S&T Solutions of Interest**  
Moderator: Mr. Keith Masback  
President, United States Geospatial Intelligence Foundation
- Panelists:  
Dr. Pete Bythrow, Chief Scientist, MASINT Management Office, DIA  
Dr. Eric Kaufman, Chief Scientist, National Counter Terrorism Center  
Mr. Michael Gilbert, Technical Executive, Innovision Directorate, NGA
- 1:30 p.m.      **Acquisition and Intelligence Community Collaboration**  
Ms. Kristen Baldwin, Acting Director,  
Systems and Software Engineering, ODUSD(A&T)
- 1:50 p.m.      **Forum Summary**
- 2:00 p.m.      **Networking Roundtable**
- 3:30 p.m.      **Adjourn**



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# **Office of the Under Secretary of Defense (Intelligence)**

**Mr. Bob Arbetter  
OUSD(I)**

**IC S&T Forum November 5, 2008**

**The overall classification of this brief is Unclassified**



# Persistent ISR

## ■ **Must:**

- ☐ **Employ** multi-INT, multi-domain **collection**
- ☐ **Provide** relevant and timely **analysis** to address the threat
- ☐ **Result in actionable information** for operators
- ☐ **Take advantage of** key enabling technologies

**Things have changed...**



# Key Collection Issues

- Multi-INT, multi-domain persistence – responsive to dynamic, tech-savvy adversaries
  - Speed of light and thought
- Integrated Tasking, Collection and Analysis Management
  - Sensor location and awareness
  - Smart tasking – include collecting on transactions and social networks
  - Analysis Gap awareness
  - Automated feed back loop to multi-discipline tasking recommendations
- Unattended Sensors
  - Integrated tasking and data access
- Operations-based collection management process – analogous to an effects based ATO
  - Collection plans must allow for long-term activities based ISR
- Non-traditional ISR (e.g. OSINT) feeding spatially and temporally searchable ISR data bases
- Collections should be able to support various timelines, from real time operator support to forensics and longer term situational awareness



# Key Analysis Issues

## ■ Integrated Intelligence Architecture

- Easy data access
  - Non-traditional data queries – not necessarily temporal or spatial
- Automated tipping and cueing up and down echelon
- COP available down to lowest tactical level; including both Red and Blue forces.
- Robust, responsive, and tested information transfer layer
- Integrated Data Centers and storage solutions for rapidly increasing volumes of data
- Predictive and forensic analysis – must understand metrics, and they are different



# Key Analysis Issues (cont.)

## ■ **Maritime and Air Domain Awareness**

- ☐ Connect the vertical dots into a horizontal theme
- ☐ Build and support COPs

## ■ **Nuclear Forensics**

- ☐ Post Detonation Attribution

## ■ **Biometrics and Social Network Analysis Integration**

## ■ **Reduced analyst workload and footprint**

- ☐ Better tools and Automated analysis optimized for their particular problem
- ☐ Make volume our friend
- ☐ Treat IMINT like SIGINT



# “Last Tactical Mile” Issues

- **Multi-level security vice “Multiple levels of security”**
  - Sensitive but releasable data at the lowest possible levels without separate networks
  - Common message and email systems
- **COP and supporting analysis down to lowest tactical level**
- **Ensure Intel drives Ops**





# Enabling Key Technologies

- Bridge the technology provider-end user gap
- Streamline technology-to-operations cycle
- Select most promising technologies and rapidly transition to operations
- Reduce barriers that hinder discovery of cutting-edge technology

**Stretch today's technologies and invest wisely in future technologies**



# Questions?

Mr. Bob Arbetter  
Director  
Collection Concepts and Strategies  
DUSD Technical Collection and Analysis  
Undersecretary of Defense for Intelligence  
(703) 692-2888



# ACQUISITION & TECHNOLOGY

THE WILL TO CHANGE

## Acquisition and Intelligence Community Collaboration

***Kristen Baldwin***

*Deputy Director, Software Engineering and System Assurance  
Office of the Deputy Under Secretary of Defense  
(Acquisition and Technology)*





# Outline



- ★ Discuss two examples of the growing collaboration between Acquisition and Intelligence communities:
  - ☆ DoD Systems Engineering Research University Affiliated Research Center
  - ☆ DoD Acquisition Cyber Security and Program Protection
- ★ Describe opportunities to engage





# Systems Engineering Research University Affiliated Research Center





# The Need



- ★ Current SE methods, processes, tools do not address the breadth, complexity, and tempo of today's development environment.
- ★ Although systems engineering is recognized as key to delivering weapon systems, there is no single body leading the effort to advance SE methods, processes, and tools (MPTs) to support DoD challenges...nor funding line.
- ★ There is an inadequate supply of systems engineers experienced with the breadth and complexity of DoD's current development environment.







# The Solution



- ★ **Provide funding for a center to lead, coordinate, and harmonize research focused on delivering improved SE MPTs that support DoD challenges**
  - ★ Establishes and maintains essential systems engineering research and analysis capabilities
  - ★ Nurtures and grows graduate-level systems engineering academic and research programs that support DoD acquisition program needs



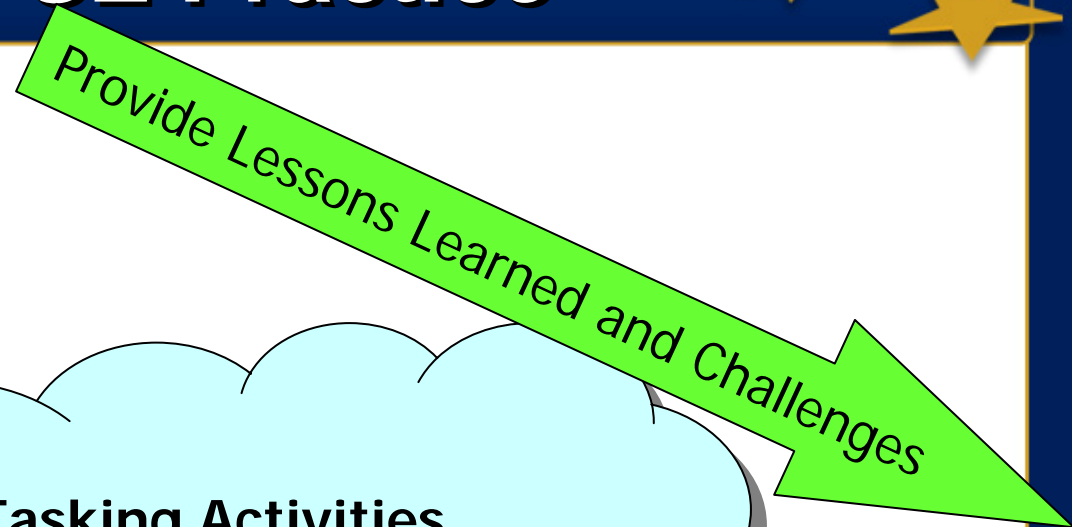




# Advancing SE Practice

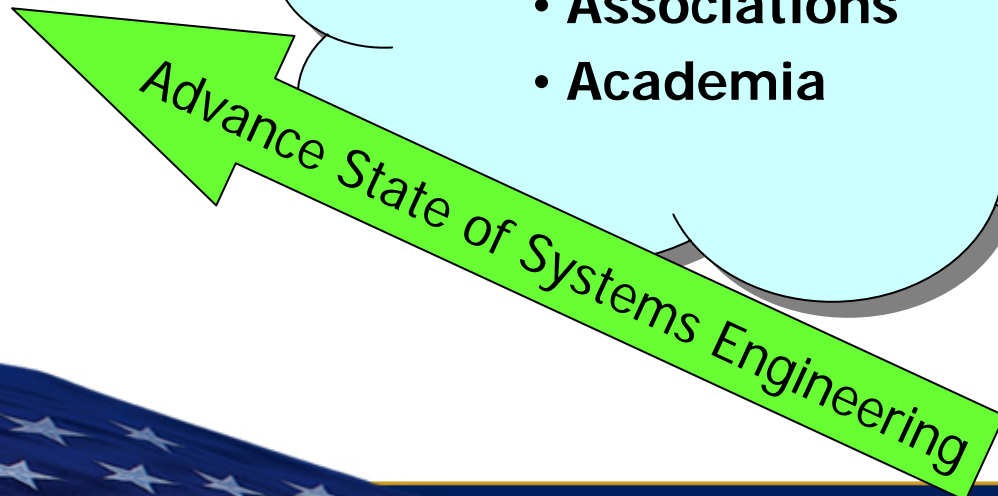


**Acquisition  
Community  
(DoD and  
Industry)**



**Provide Lessons Learned and Challenges**

- Tasking Activities
- Industry
- Associations
- Academia



**Advance State of Systems Engineering**



**SER  
UARC**





# SER UARC Mission



To research and analyze advanced and emerging systems engineering practices and relevant technologies to address the full spectrum of DoD and Intelligence systems across the Department

**Goal: Ensuring consistency and systems engineering excellence throughout the acquisition cycle**





# SER UARC Team

## UARC Lead Organizations

**STEVENS**  
Institute of Technology



## Members

- ★ Auburn University
- ★ Air Force Institute of Technology
- ★ Carnegie Mellon University
- ★ Fraunhofer Center at UMD
- ★ Massachusetts Institute of Technology
- ★ Missouri University of Science and Technology (S&T)
- ★ Pennsylvania State University
- Southern Methodist University
- Texas A&M University
- Texas Tech University
- University of Alabama in Huntsville
- University of California at San Diego
- University of Maryland
- University of Massachusetts
- University of Virginia
- Wayne State University





# Summary



- ★ **UARC will address SE research challenges across DoD and the Federal Government**
- ★ **Research results (new/improved MPTs) will be shared across Government and industry to improve SE practice.**
- ★ **Opportunity for DoD and Industry investment**
  - ☆ **Advance the state of Systems Engineering**
  - ☆ **Nurture and grow graduate-level systems engineering academic and research programs**

UARC Program Manager  
Dennis Barnabe  
drbarnab@nsa.gov

UARC Deputy PM  
Sharon Vannucci  
sharon.vannucci@osd.mil





# DoD Cyber Security And Program Protection







# Increased Priority for Program Protection

- ★ **Threats:** Nation-state, terrorist, criminal, rogue developer who:
  - ★ Gain control of IT/NSS/Weapons through supply chain opportunities
  - ★ Exploit vulnerabilities remotely
- ★ **Vulnerabilities:** All IT/NSS/Weapons (incl. systems, networks, applications)
  - ★ Intentionally implanted logic (e.g., back doors, logic bombs, spyware)
  - ★ Unintentional vulnerabilities maliciously exploited (e.g., poor quality or fragile code)
- ★ **Consequences:** Stolen critical data & technology; corruption, denial of critical warfighting functionality

*System Assurance is the confidence that the system functions as intended and is free of exploitable vulnerabilities, either intentionally or unintentionally designed or inserted during the lifecycle*

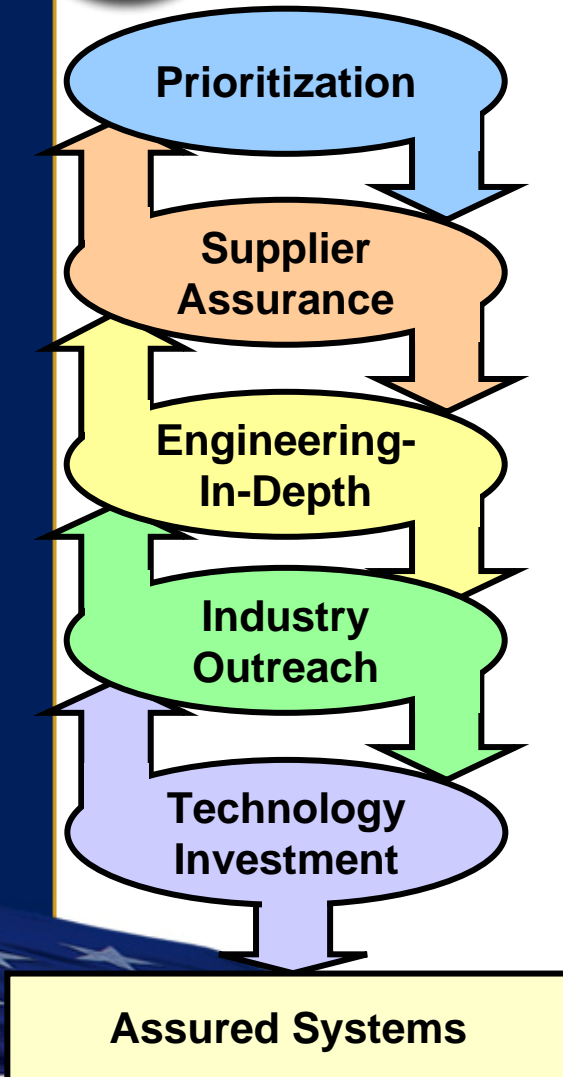




# The Solution Components

## Vision of Success

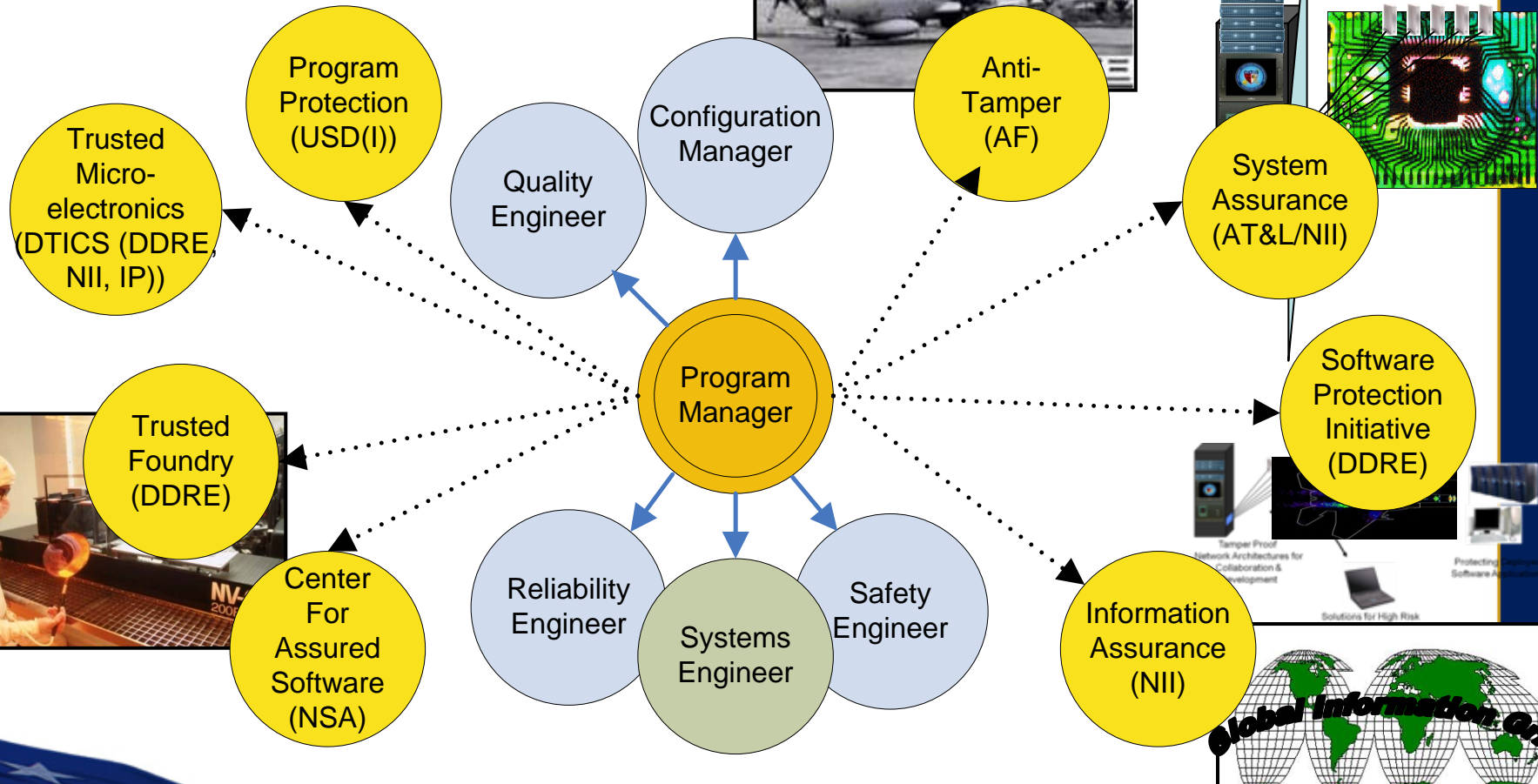
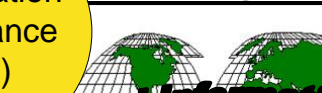
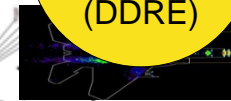
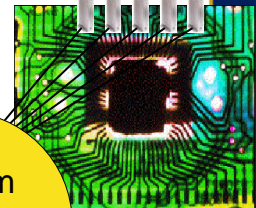
- ★ The requirement for assurance is allocated among the right systems and their critical components
- ★ DoD understands its supply chain risks
- ★ DoD systems are designed and sustained at a known level of assurance
- ★ Commercial sector shares ownership and builds assured products
- ★ Technology investment transforms the ability to detect and mitigate system vulnerabilities







# Numerous Defensive Protection Strategies and Related Engineering Disciplines



Protection implemented via multiple initiatives with multiple owners



# Several Assurance Efforts in Acquisition

- ★ **Defense Industrial Base Cyber Security**
  - ★ DIB Information Sharing
  - ★ Implementing Cyber Security on Contracts
  - ★ Interim Policy and Near Term Pilots with Programs and Industry
- ★ **Program Protection Planning**
  - ★ Policy requiring all programs identify Critical Program Information (CPI) at MS A and submit PPP at MS B
  - ★ Guidance and Procedures in development
- ★ **Engineering for System Assurance Guidebook**
  - ★ Systems Engineering and Acquisition Life-Cycle Overlay for Assurance
  - ★ Joint Industry and Government effort, released 1 Oct 08





# Critical Program Information

- ★ **“CPI. Elements or components of an RDA program that, if compromised, could cause significant degradation in mission effectiveness;**
  - ★ Includes information about applications, capabilities, processes, and end-items.
  - ★ Includes elements or components critical to a military system or network mission effectiveness.
  - ★ Includes technology that would reduce the US technological advantage if it came under foreign control...”

*DoDI 5200.39*





# Program Protection Envisioned Benefit



## Program Benefit

- ★ Coherent direction and integrated policy framework to respond to security requirements
- ★ Risk-based approach to implementing security
- ★ Provision of expert engineering and intelligence support to our programs
- ★ Streamline process to remove redundancy; focus on protection countermeasures

## DoD Benefit

- ★ Reduced risk exposure to gaps/seams in policy and protection activity
- ★ Improved oversight and focus on system assurance throughout the lifecycle
- ★ Ability to capitalize on common methods, instruction and technology transition opportunities
- ★ Cost effective approach to “building security in” where most appropriate







# Expanding DoD Industry Partnership

- ★ Acquisition Cyber Security is a long term interest for DoD
  - ★ Fully anticipating Cyber Security is expected to be a ongoing priority for the new administration
- ★ DoD will continue to take advantage of the global marketplace and COTS solutions
  - ★ Engineering for System Assurance seeks to identify and fortify critical components allowing incorporation of COTS
  - ★ Industry outreach must explore strategy for commercially reasonable assurance for globally sourced products
- ★ Industry is part of the solution
  - ★ NDIA System Assurance Committee will continue to focus on the solution strategy
  - ★ ITAA, GEIA, INCOSE, others all participate on this committee





# NDIA Conference November 4<sup>th</sup>, 2008





# ISR Innovations and UAV Task Force Directorate



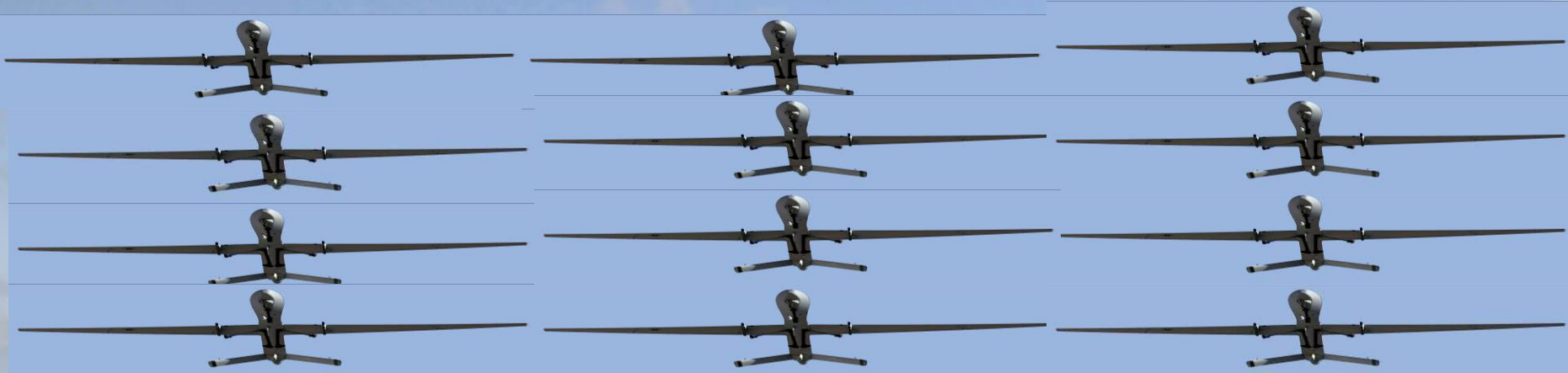
**November 2008**



***He's armed and dangerous***  
***And now he's an actual "Intel Guy"***



# USAF UAV Task Force





# Yoda of Predator

Tazar AB Hungary 1996



Kandahar AB Afghanistan 2008



*A2-U's Expertise:*

*We've done it longer than anyone else.*

*We built many of the capabilities.*

*Our personnel are flying it today.*

**\*\*And Snake can still fit into a Flight Suit**

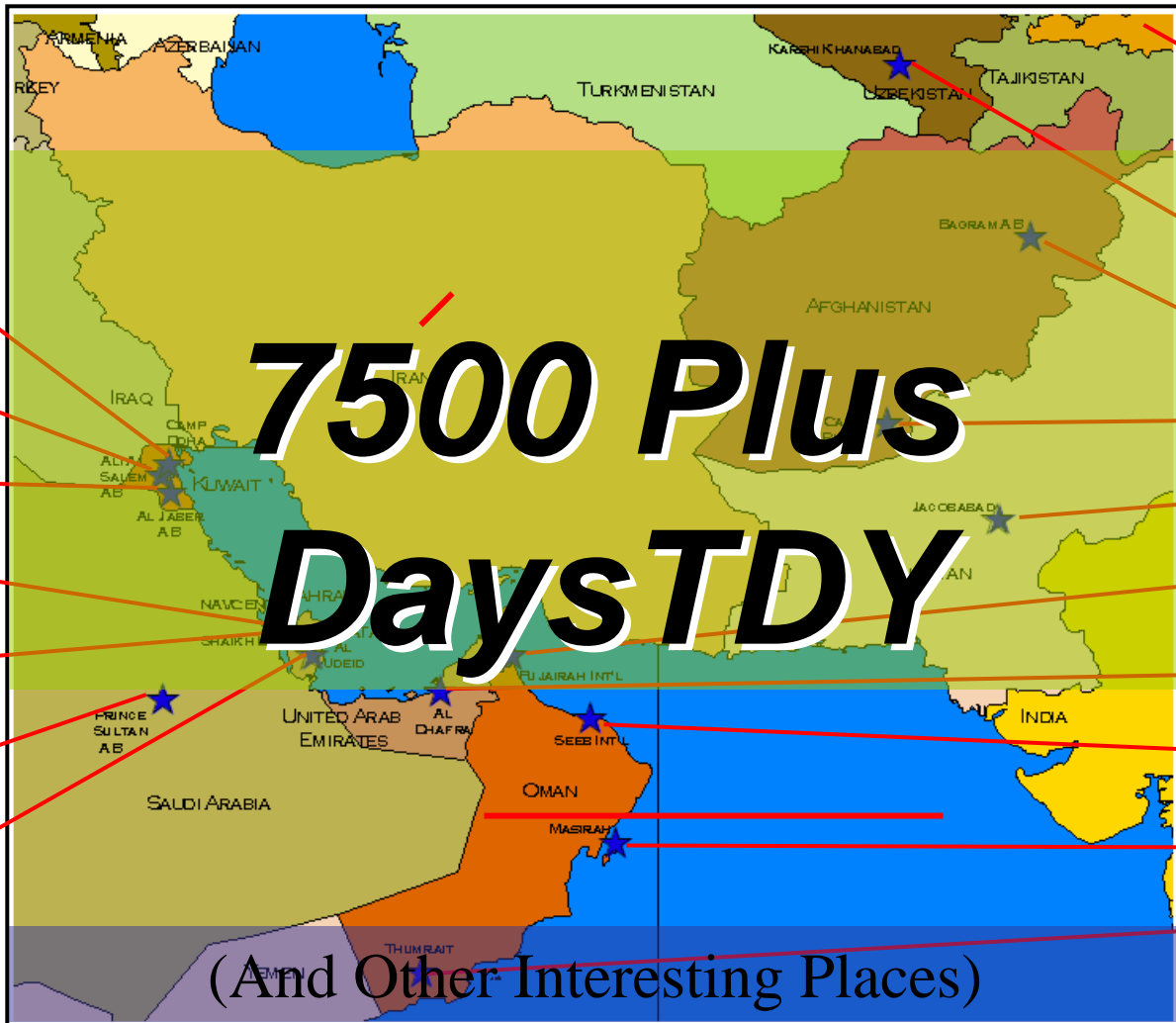


# A2-U in the AOR

June 2001 – August 2008



- Balad
- Baghdad
- Tallil
- Camp Doha
- Ali Al Salem
- Al Jaber
- NAVCENT
- Shaikh Isa
- PSAB
- Al Udeid



- Manas Kyrgyzstan
- Karshi Khanabad
- Bagram
- Camp Rhino
- Jacobabad
- Fujahra
- Al Dhafra
- Seeb
- Masirah
- Thumrait

(And Other Interesting Places)





# MQ-1 Predator Reaches 440,000 hours



**4000 + Weekly Combat Hours**  
**28 Combat CAPS**

***MQ-9 Reaper 30,000 hours***



**Over 400 Combat hours a week**

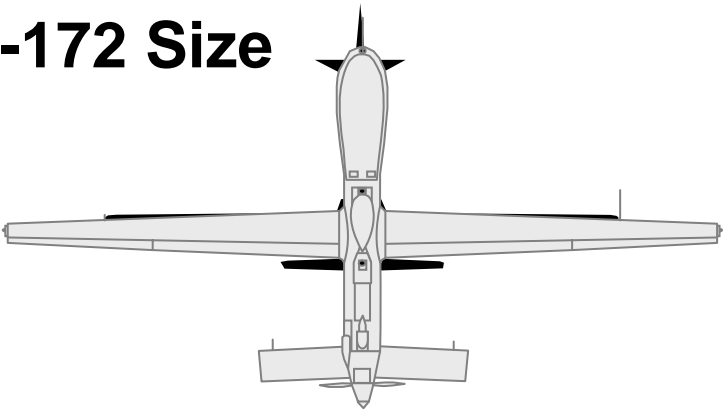


# MQ-1/MQ-9 Comparison

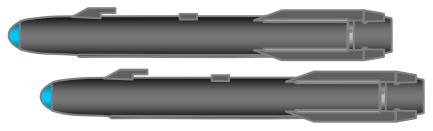
**MQ-1**

**MQ-9**

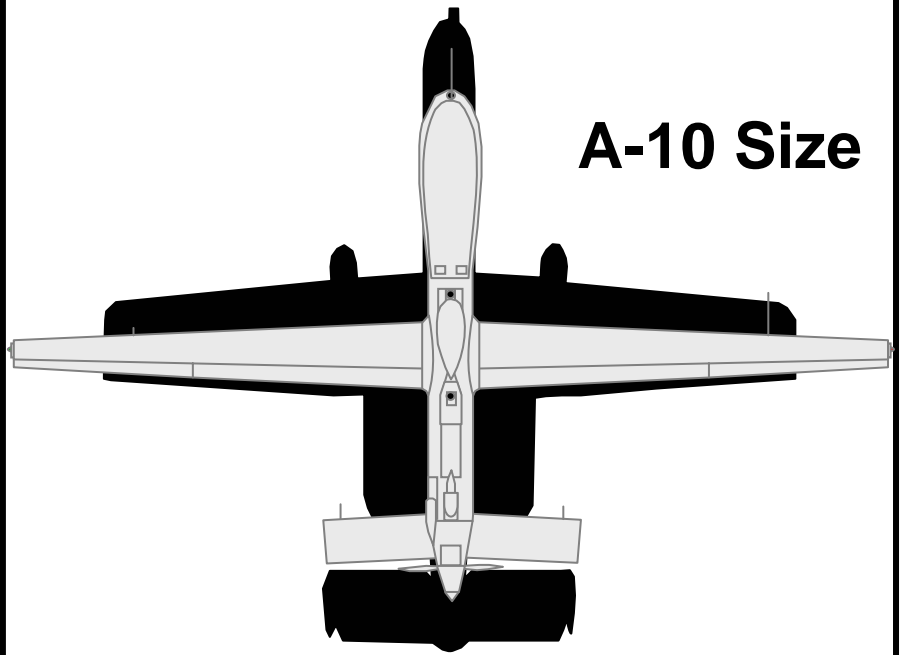
**C-172 Size**



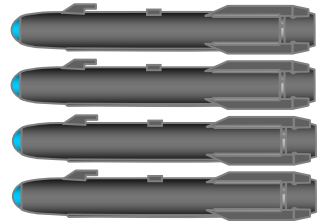
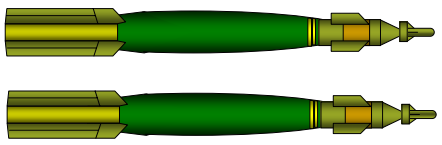
**2 x Hellfire**



**A-10 Size**



**2 X 500 lb bombs & 4 x Hellfire**







# Smart reach back UAV Operations

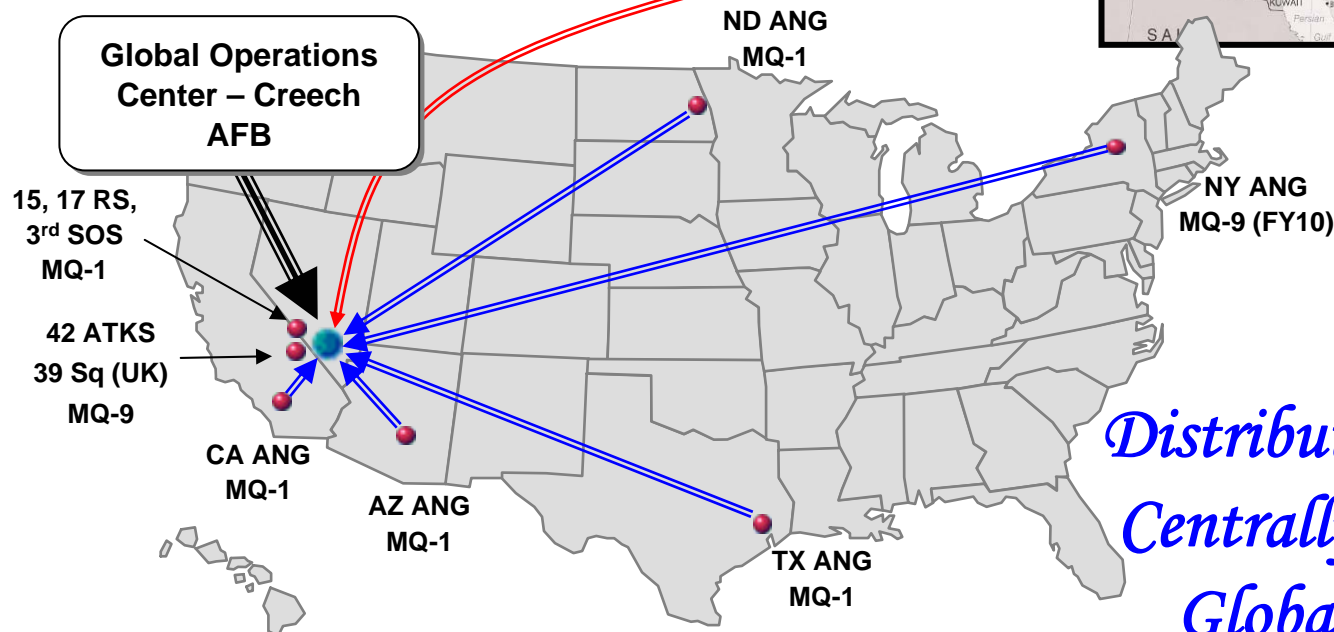


## Total Force Operations

Active Duty, Reserve, National Guard,  
Special Operations, United Kingdom

6 - Stateside operations centers

5 - Launch and recovery units in theater



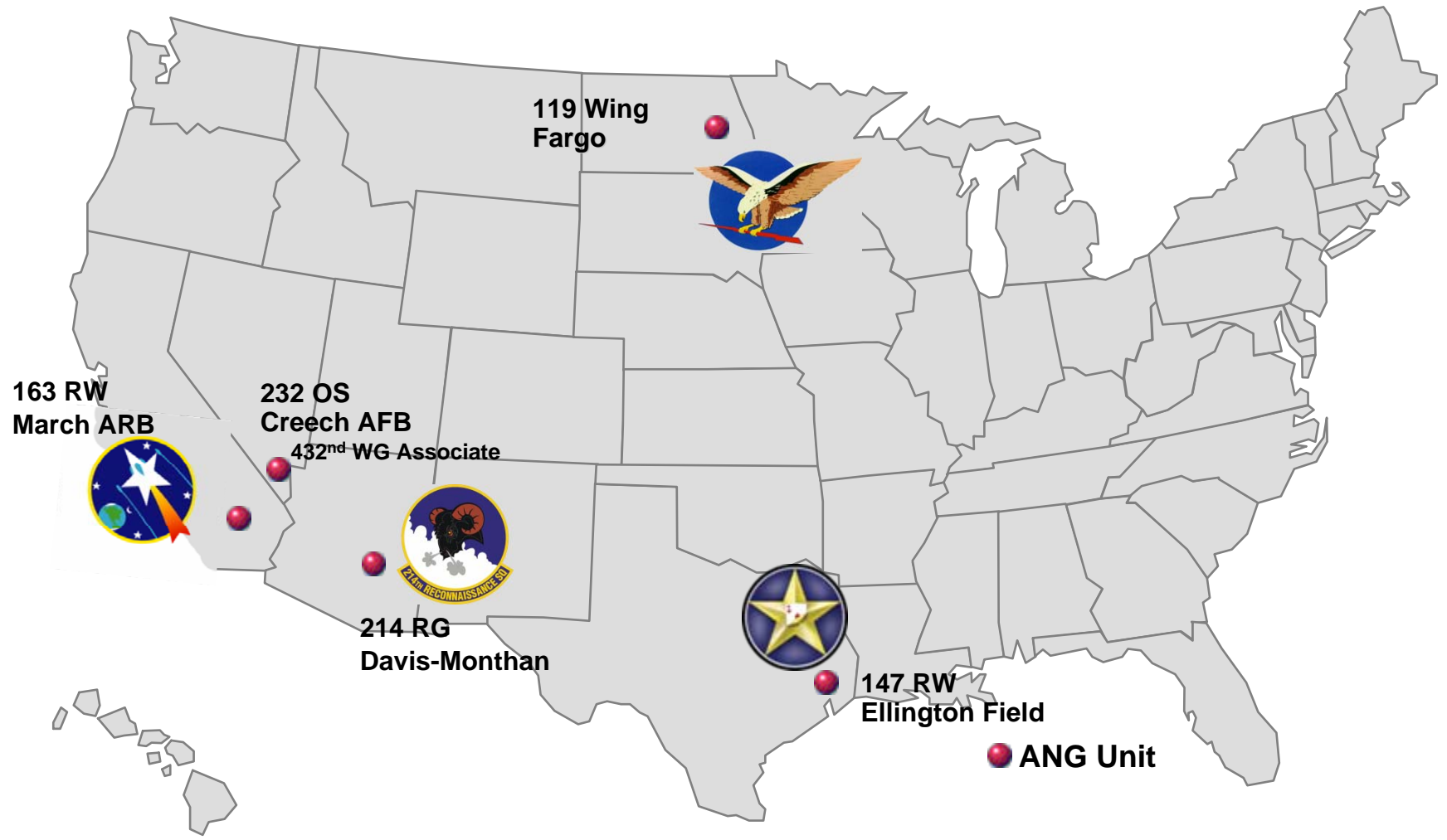
*Distributed Operations  
Centrally Coordinated  
Globally Applied*

**Over 1000 personnel flying Combat Operations not in harms way**





# ANG MQ-1 Organization





# ***Air National Guard Total Force Transformation***



- **Convert BRAC units to new UAVs Mission**
- **Maintaining years of Aircrew experience**  
(F-4, F-15, F-16, F-117, A-10, B-52, C-5, C-17, C-21, C-130, KC-135, & AH-64)
- **From a high time of 5000+ hours to an average of over 1500 hours**
- **Minimum training for High Combat Experience**
- **Maintaining extensive Maintenance, Logistics, Training, Intel Support, and Facilities to the new mission at a minimum cost**

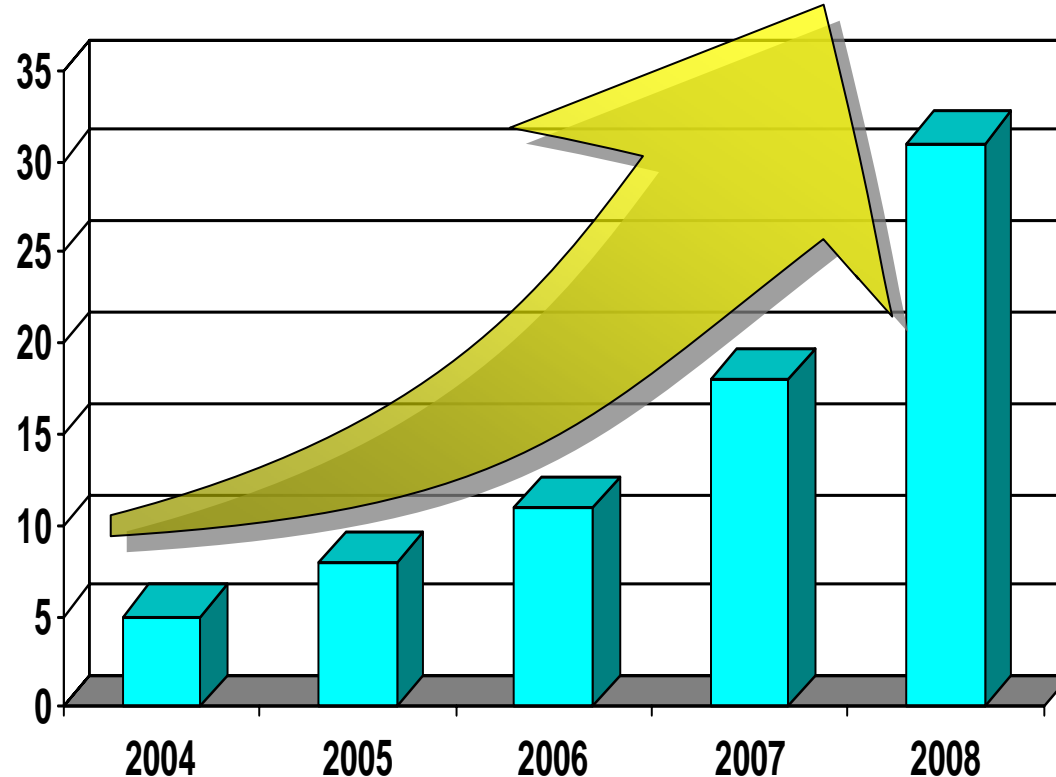
**Bottom line: Flying, armed UAV's is not simple  
13 ½ years and 450 K hours lesson learned**



# Predator Combat Growth

## Air Force MQ-1B Predator Combat Air Patrols

- 2004 = 5
- 2005 = 8
- 2006 = 11
- 2007 = 18
- 2008 = 31  
(Planned)



**520% Increase in 4 years!**



# Predator Innovations

<i>Laser Designator</i>	<i>Kosovo</i>	<i>38 Days</i>
<i>Hellfire</i>	<i>2001</i>	<i>61 Days</i>
<i>Remote Split Ops</i>	<i>2001</i>	<i>5 Days</i>
<i>Stinger</i>	<i>2002</i>	<i>91 Days</i>
<i>ROVER</i>	<i>2002</i>	<i>4 Days</i>
<i>Hellfire Sleeve</i>	<i>2002</i>	<i>21 Days</i>
<i>GBU-12</i>	<i>2003</i>	<i>9 Months</i>
<i>Link-16/SADL</i>	<i>2004</i>	<i>8 Months</i>

*FalconView Multi-Predator Tool, Super Splitter, Cursor on Target, UAS Mission Information System, Blue Force Tracking, Civil Air Tracks, ISR Information Services, Wing/Squadron C2, Predictive Control Displays, Predator FalconView enhancements . . .*



# ROVER

## Full Motion Video directly to the Warfighter



**Predator**

**SNIPER Pod**

**Litening Pod**

**P3**

**Raven**

**Pioneer**

**Pointer**

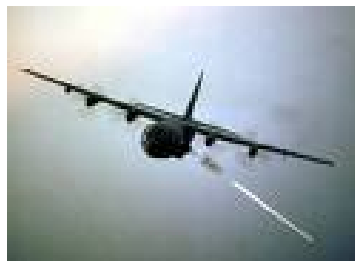
**AC-130**

**Shadow**

**Hunter**

**Fire Scout**

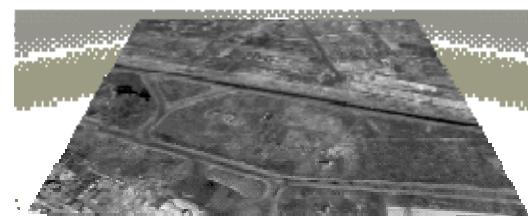
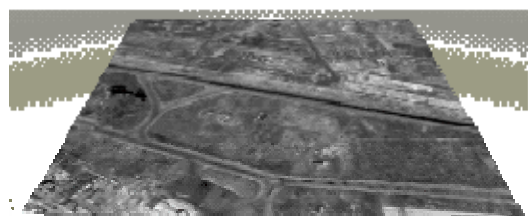
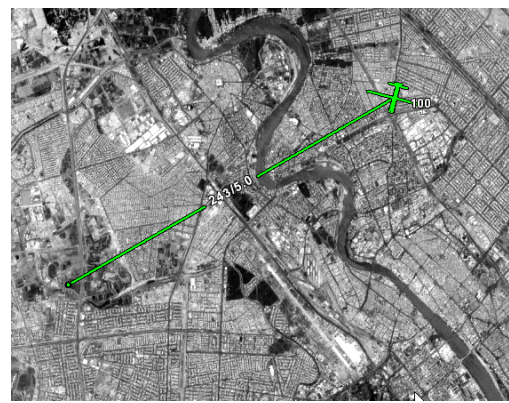
**Scathe View**







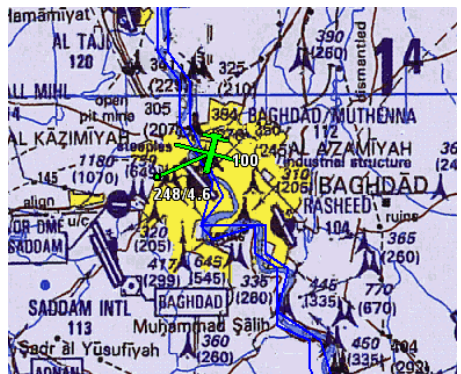
# ROVER Big Picture



**PSS-SOF Precision Targeting**



**FalconView  
Maps  
+  
Imagery**



**ROVER**



# ROVER

## Revolutionizes the Battlefield

*Over 14 NATO and ISAF countries use ROVER*

- |          |             |           |                     |
|----------|-------------|-----------|---------------------|
| – UK     | France      | Australia | Germany             |
| – Norway | New Zealand | Canada    | Portugal            |
| – Italy  | Spain       | Sweden    | Belgium Netherlands |



**85% of CAS mission done  
with ROVER in OIF**





# Fielded ROVERs



ROVER I: (Pred to AC-130)  
Total Delivery – 20

ROVER II: (Aircraft to JTAC)  
Total Delivery 147

ROVER III – Multi-band receiver C/L/KU  
Total Delivery 2331



ROVER IV  
Total Delivered 1169



ROVER V  
On Order 9

**ROVER 4200**



**OSRVT 1083**

ROVER Recycling Program Upgrade  
ROVER 3's to ROVER 4's only \$7K



# ROVER 5 Test Sep 08

- Full Encryption
- 4 pounds
- John Madden
- Full production Nov 08







OEF Coalition Warfare  
38 Nations in ISAF  
All members must have the same maps and imagery





# A2-U Afghanistan Eagle Express



- *145 Laptops computers with NATO releasable maps and imagery on FalconView*
  - *Six Regional Commands*
  - *Provided FV training*





# Enhanced Combat Situational Awareness



*It's not the number of UAV's that are in the sky, it's how you get the data to the lowest tactical level*

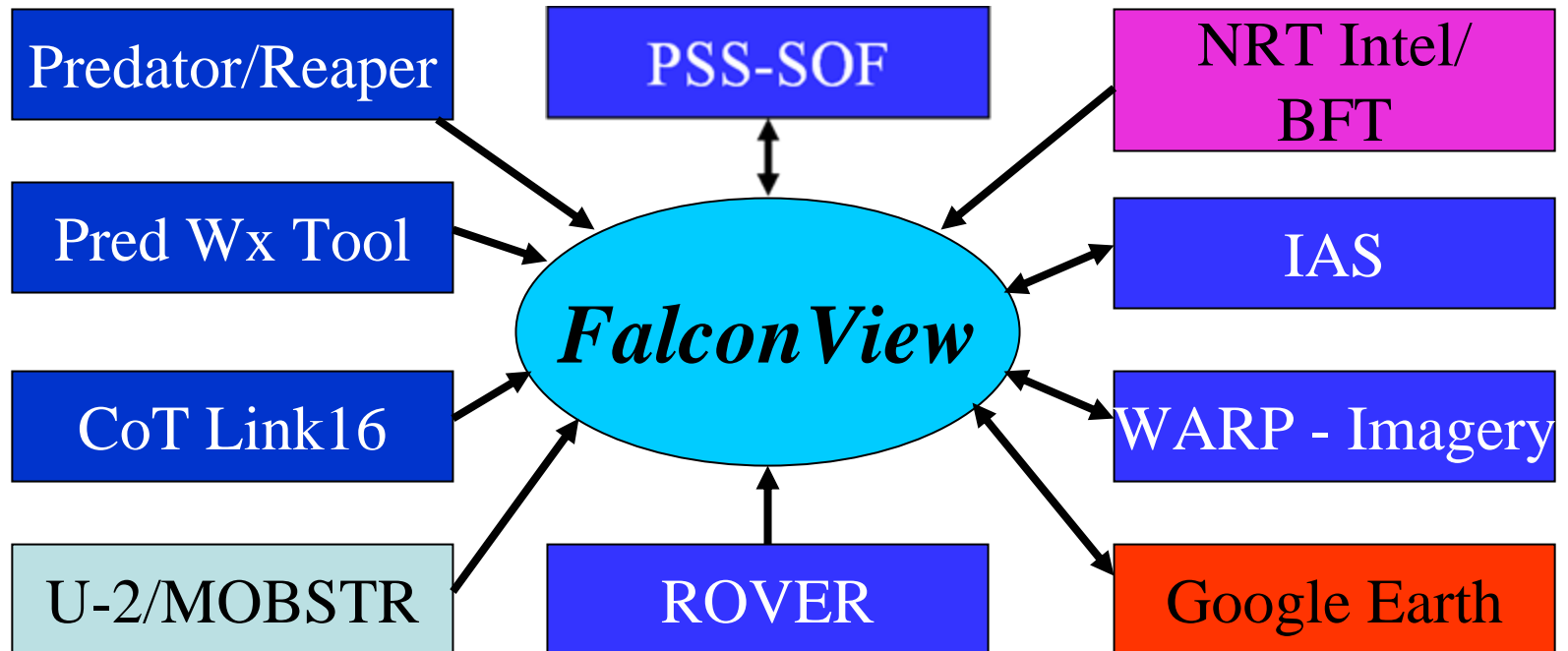




# Falcons View New Technology

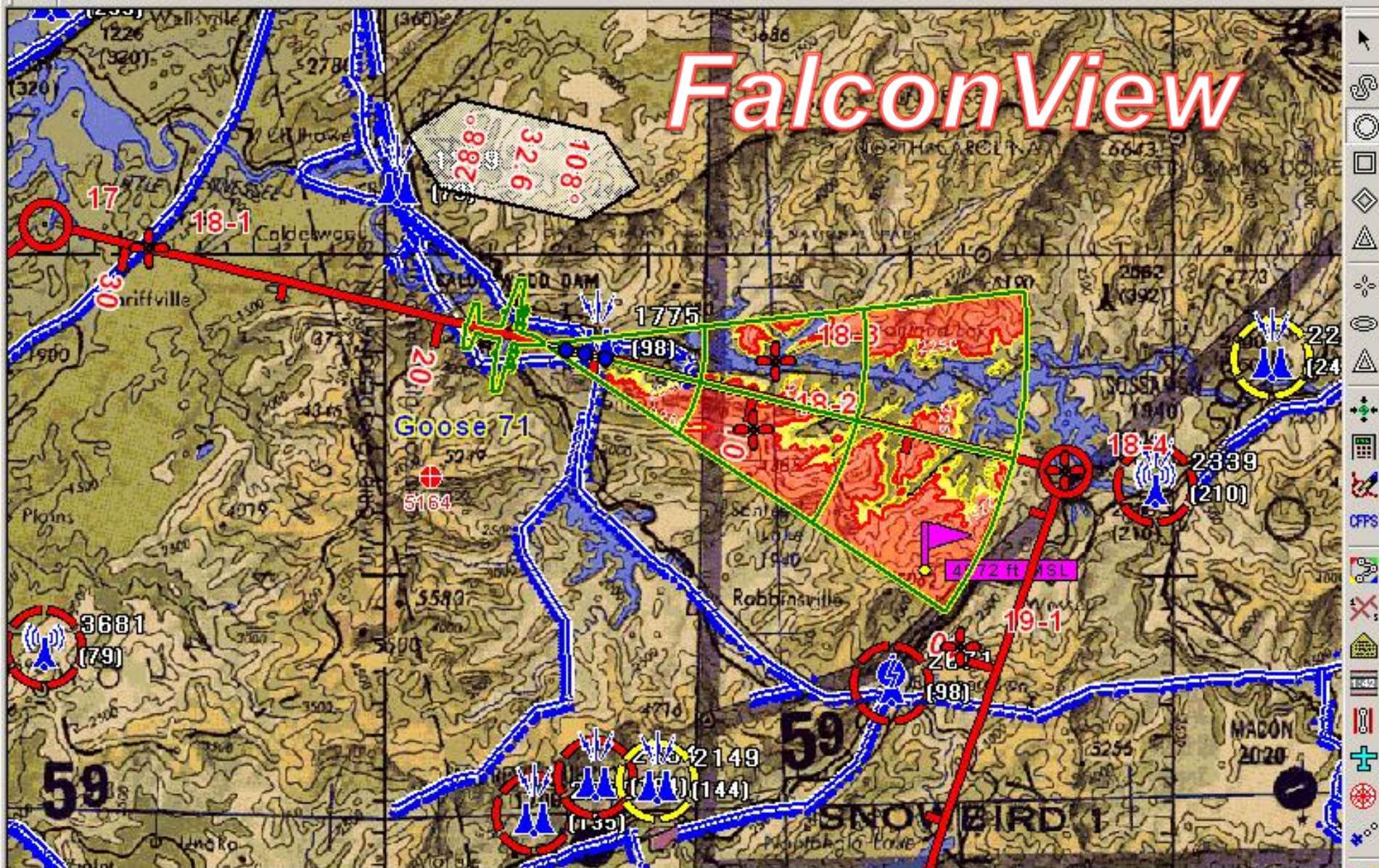


**Increasing Connectivity – the “glue” that provides SA to the operator**



**Even used on Air Force One!**



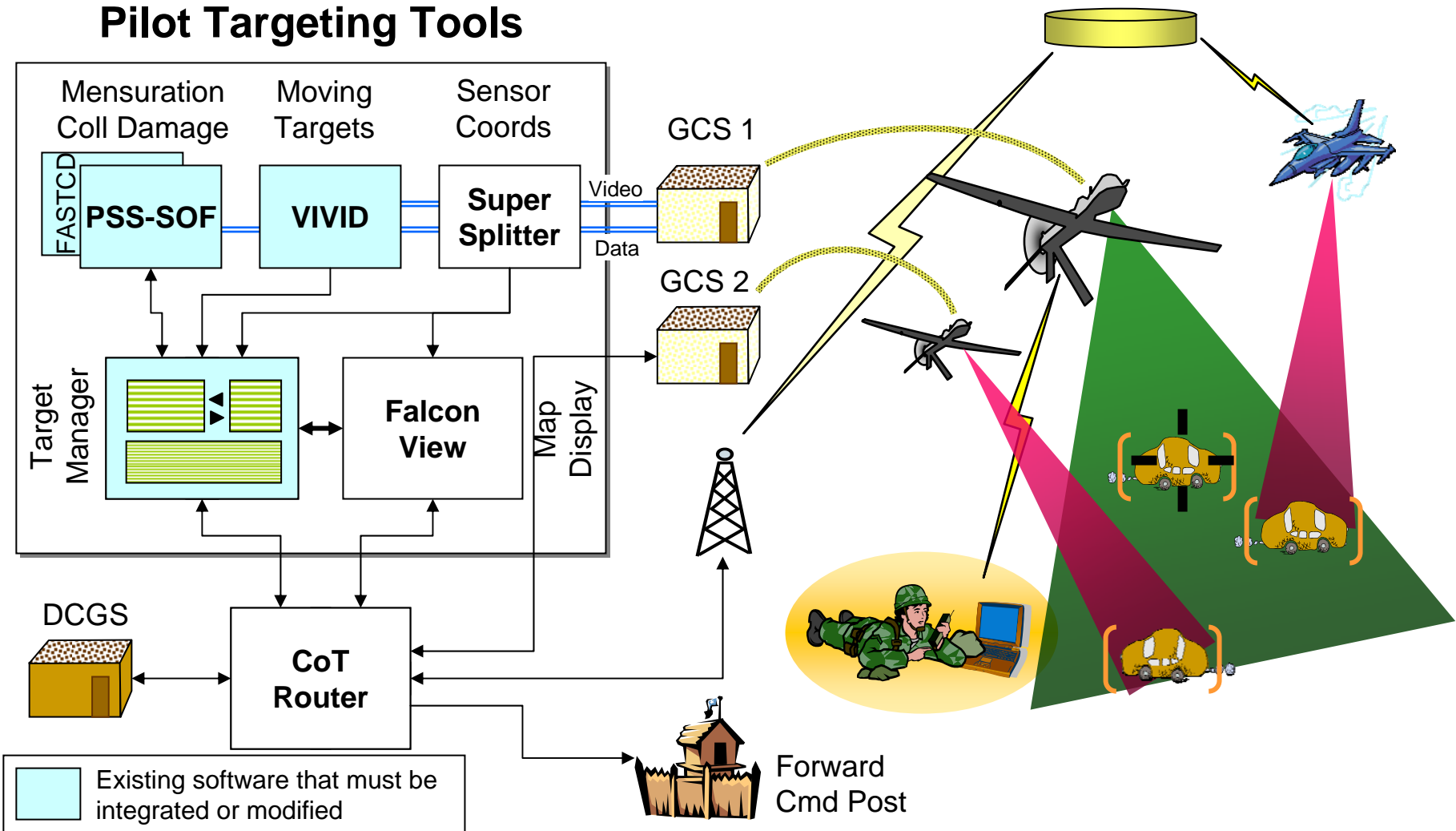






# Predator Reaper Integrated Targeting

## Pilot Targeting Tools





# ROVER & FalconView Support



A2-U ROVER Team



ROVER Video posted NORTHCOM website



Fire Fighter (Don Green) embedded with A2-U



FalconView Training for State Fire Chief

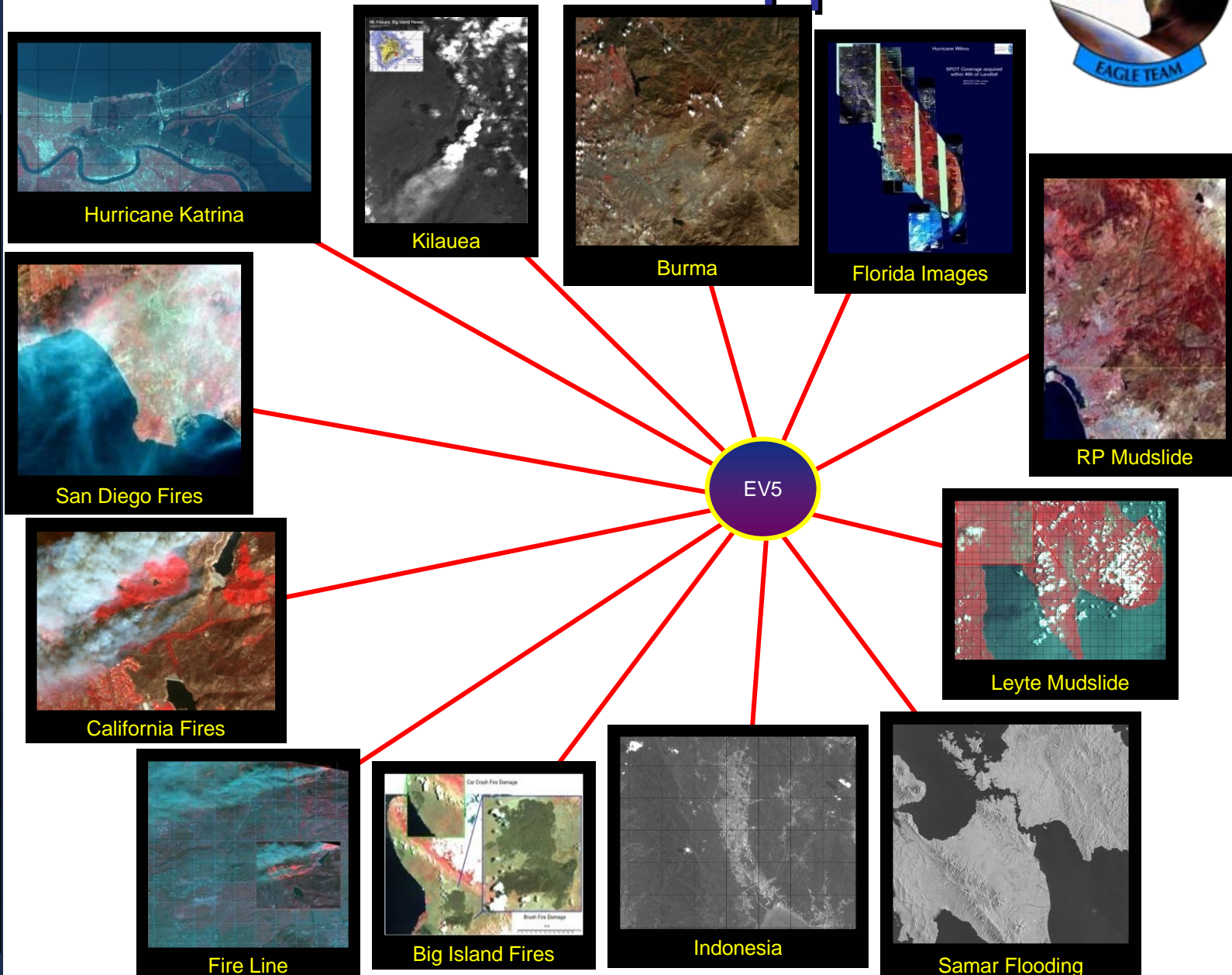




# EV5 Worldwide Support



- Hurricane Katrina
- San Diego Fires
- Northern CA
- Fire Lines
- Big Island Fires
- Tsunami Assistance
- RP Flooding
- RP Mudslide
- US Natural Disasters
- Burma Cyclone
- Volcano





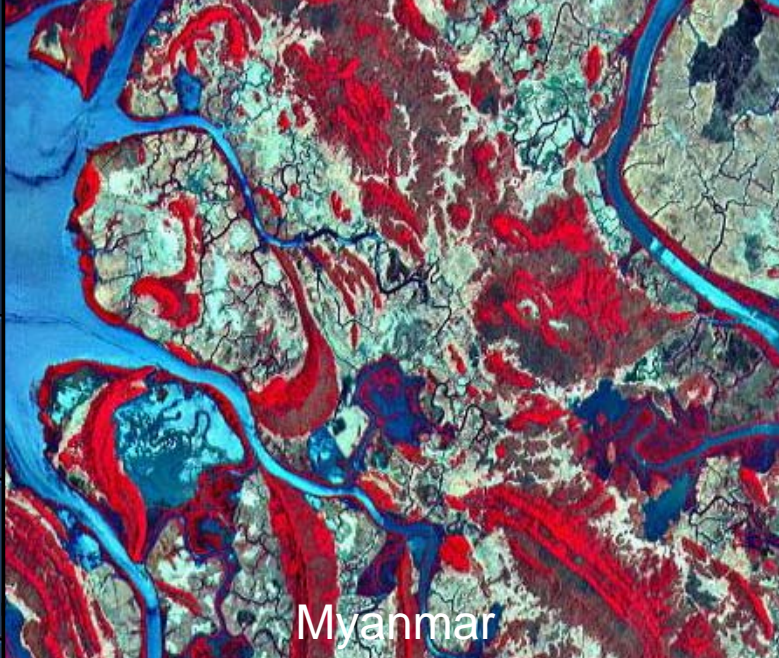


IKONOS

SPOT-5

SPOT-4

SPOT-2



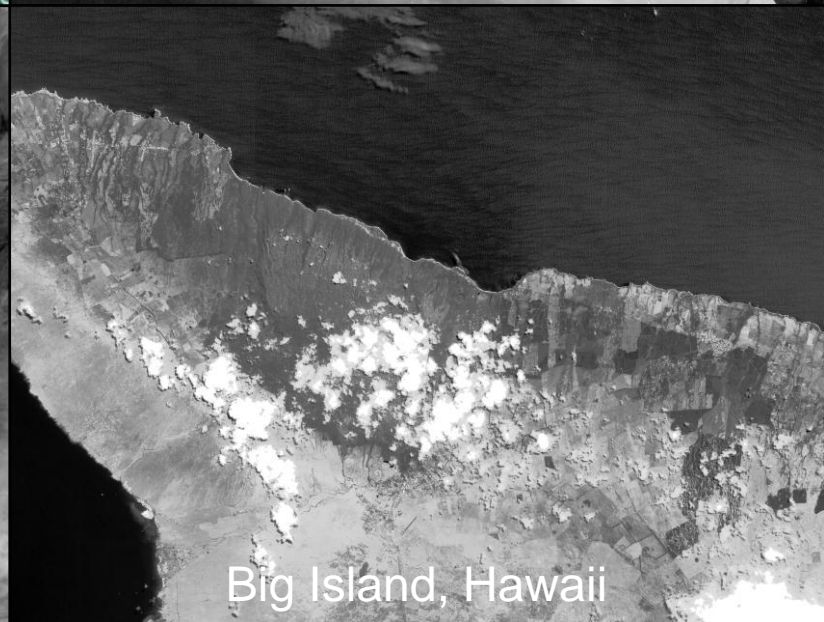
Myanmar



Malaysia



Nellis AFB



Big Island, Hawaii

Resolution: 20 meter  
Revisit Time: 2-3 Days

Imagery: EO Panchromatic & Multispectral  
Times: 1000-1400  
License: Title 50





IKONOS

SPOT-5

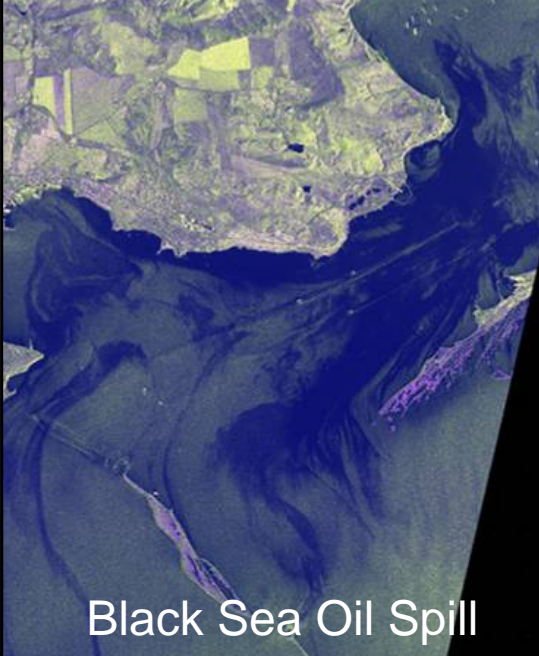
SPOT-4

SPOT-2

RADARSAT-1

RADARSAT-2

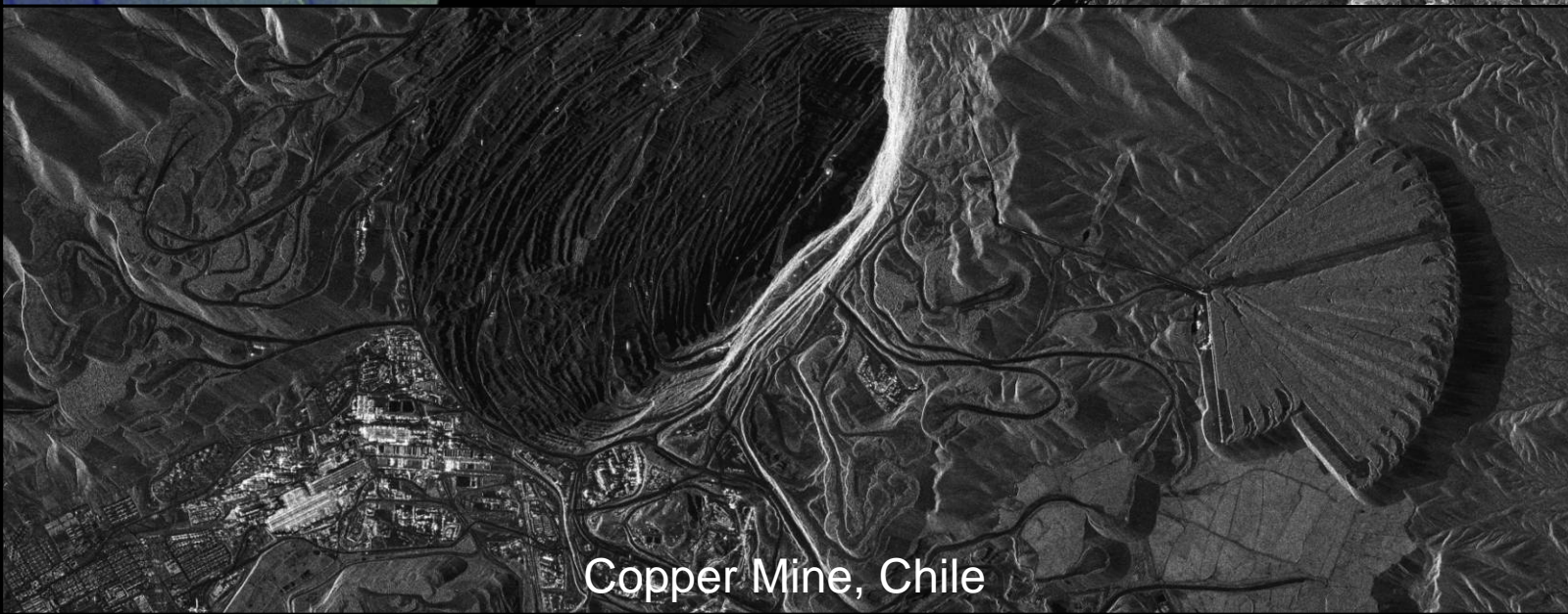
TerraSAR-X



Black Sea Oil Spill



Strait of Gibraltar



Copper Mine, Chile

Resolution: 1, 3, 9, 16 & 32m

Imagery: Radar License: Title 50

Revisit Time: 2-3 Days

Times: 0530-0730 & 1730-1930



# Smithsonian NASM

## Dedication 23 Apr 2008



16 Sep 01 thru 25 Jul 03  
Combat Sorties 196  
Combat Hours 2606

1<sup>st</sup> Hellfire Test 16 Jan 01  
1<sup>st</sup> Hellfire Combat Shot 07 Oct 01







# USAF Way Ahead



- Support Today's Fight
  - Increase Combat CAPs
  - Increase MQ-9 Reaper Deployments
- Continue Innovation and Rapid Fielding
- Improve Full Motion Video to the Warfighter
- Improve Interoperability of Multiple Systems
- Next Generation MQ-X



**A2U**



# Questions???





# **Operational Neuroscience**

## **Intelligence Community Forum**

**Dr. Amy Kruse  
Program Manager  
DARPA/DSO  
Nov 5, 2008**

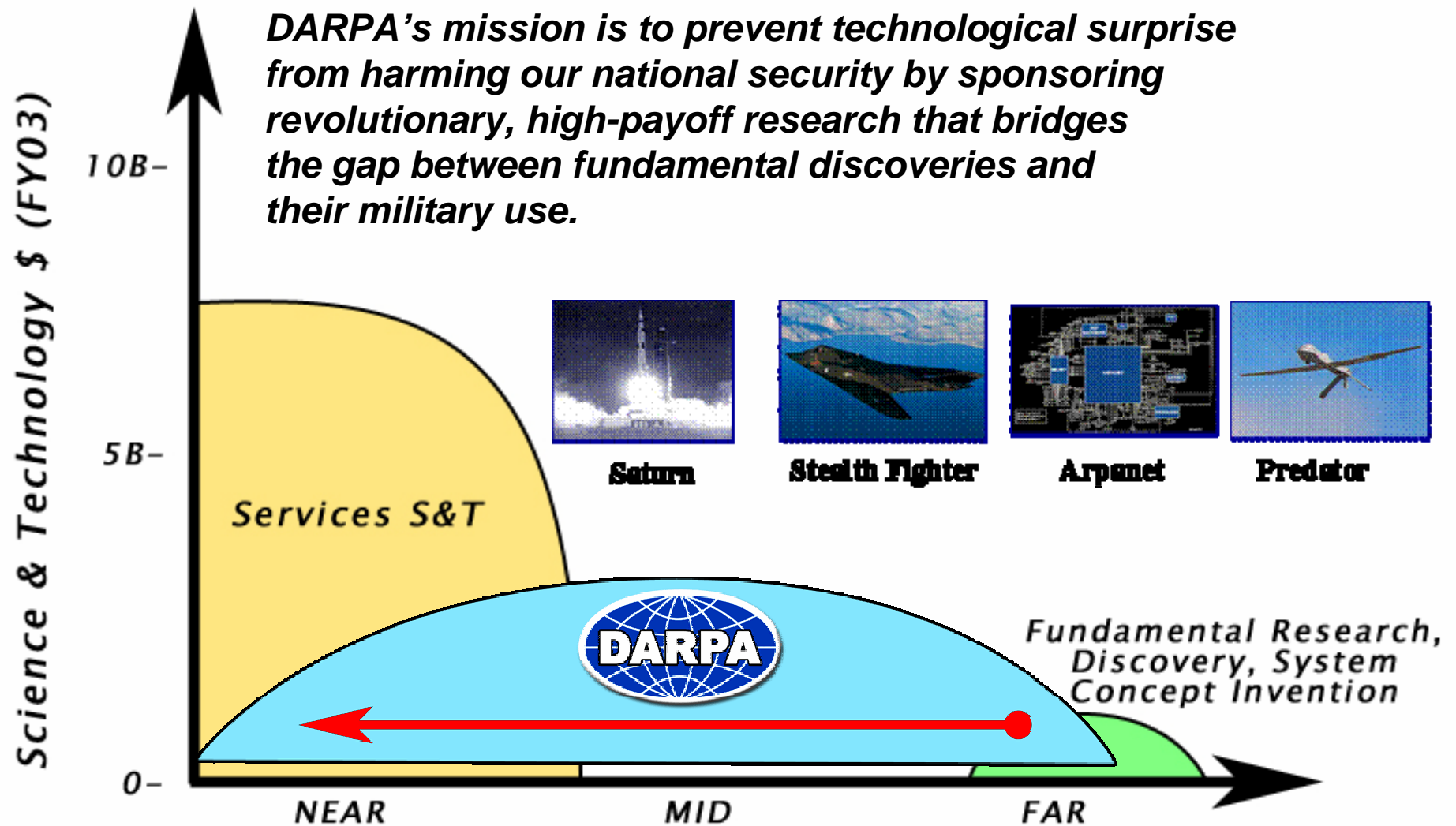




# DARPA's Mission



*DARPA's mission is to prevent technological surprise from harming our national security by sponsoring revolutionary, high-payoff research that bridges the gap between fundamental discoveries and their military use.*







# DARPA Strategic Vision



## Strategic Thrusts

- Precision detection, tracking, and destruction of elusive targets
- Characterization of underground structures
- Urban Operations
- Networked manned & unmanned attack operations
- Assured use of space
- Cognitive systems
- **Bio-Revolution**
- Robust, secure self-forming networks

## Enduring Foundations

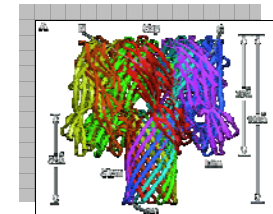
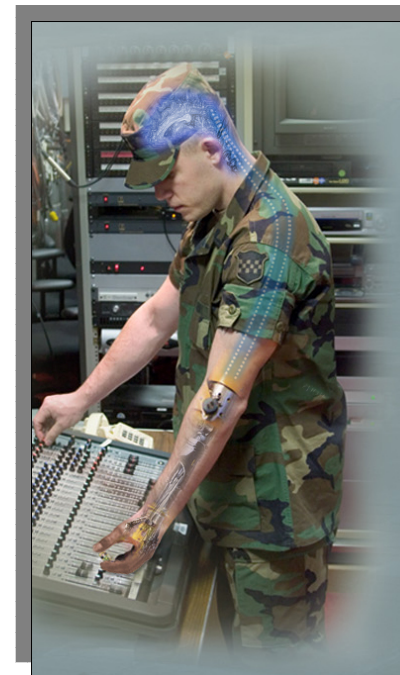
- Materials
- Microsystems
- Information Technologies



Bio-Detection

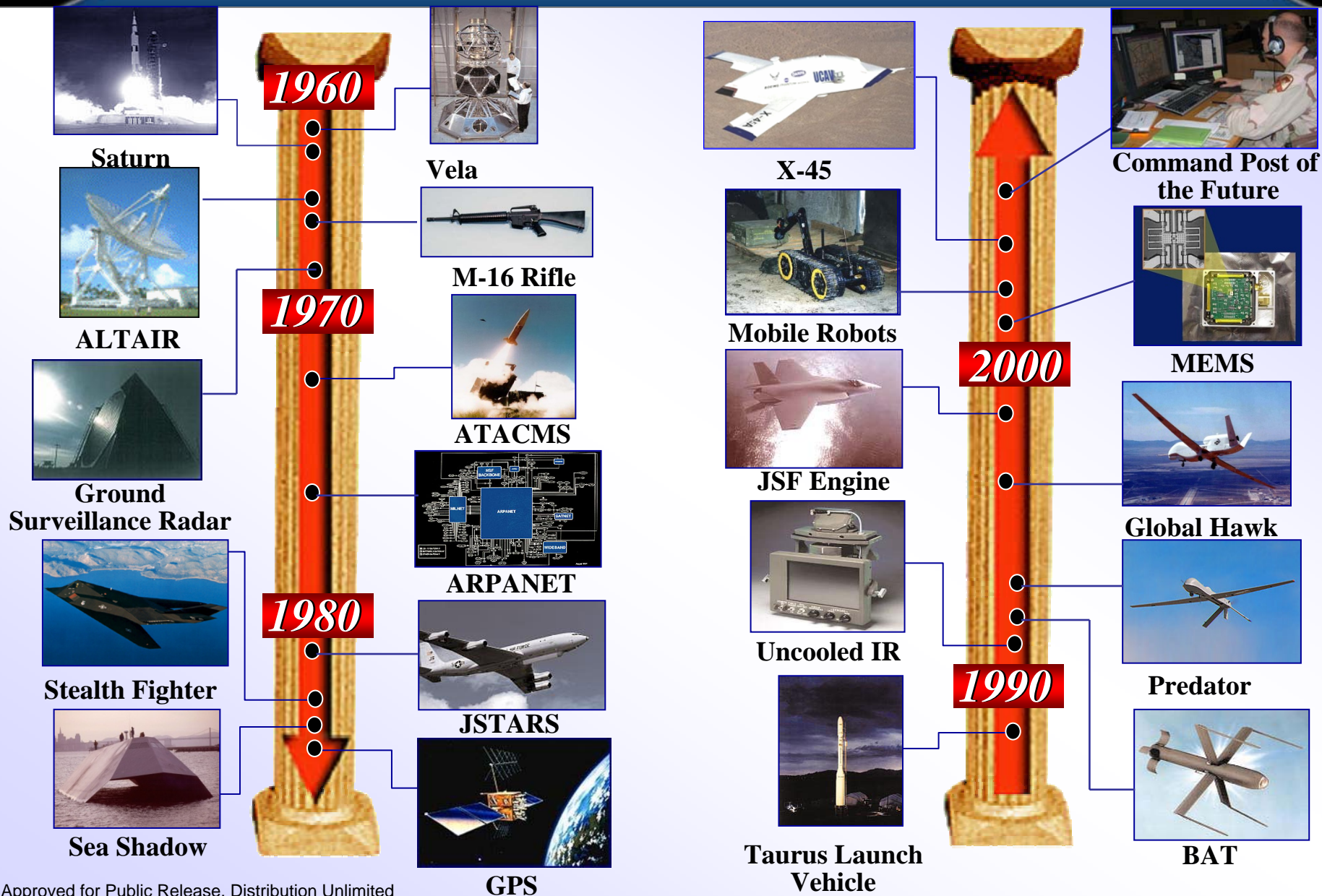


Chlorine Dioxide





# DARPA Accomplishments







# DARPA Accomplishments



Saturn



ALTAIR



Ground Surveillance Radar



Stealth Fighter



Sea Shadow

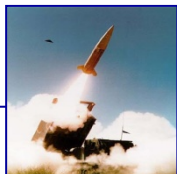
1960



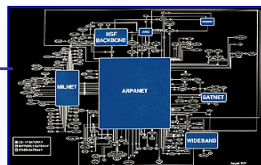
Vela



M-16 Rifle



ATACMS



ARPANET



JSTARS



GPS

1970

1980



X-45



Mobile Robots



JSF Engine



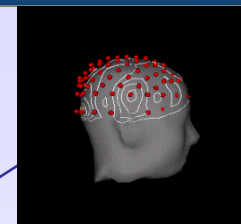
Uncooled IR



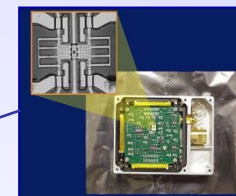
Taurus Launch Vehicle

2000

1990



Operational Neuroscience



MEMS



Global Hawk



Predator



BAT



# DARPA Technical Offices



**Director, Tony Tether**  
**Deputy Director, Bob Leheny**

## Tactical Technology

**Dave Neyland**  
**Steve Walker**

- Air/Space/Land/Sea Platforms
- Unmanned Systems
- Space Operations
- Laser Systems
- Precision Strike

## Strategic Technology

**Barbara McQuiston**  
**Larry Stotts, Brian Pierce**

- Space Sensors/Structures
- Strategic & Tactical Networks
- Information Assurance
- Underground Facility Detection & Characterization
- Chem/Bio Defense
- Maritime Operations

## Defense Sciences

**Bob Leheny (Acting)**  
**Leo Christodoulou**

- Physical Sciences
- Materials
- Biology
- Mathematics
- Human Effectiveness
- Bio Warfare Defense

## Information Processing Techniques

**Chuck Morefield**  
**Charlie Holland**

- Cognitive Systems
- Command & Control Systems
- Computer Language Translation
- High Productivity Computing
- Sensors & Processing

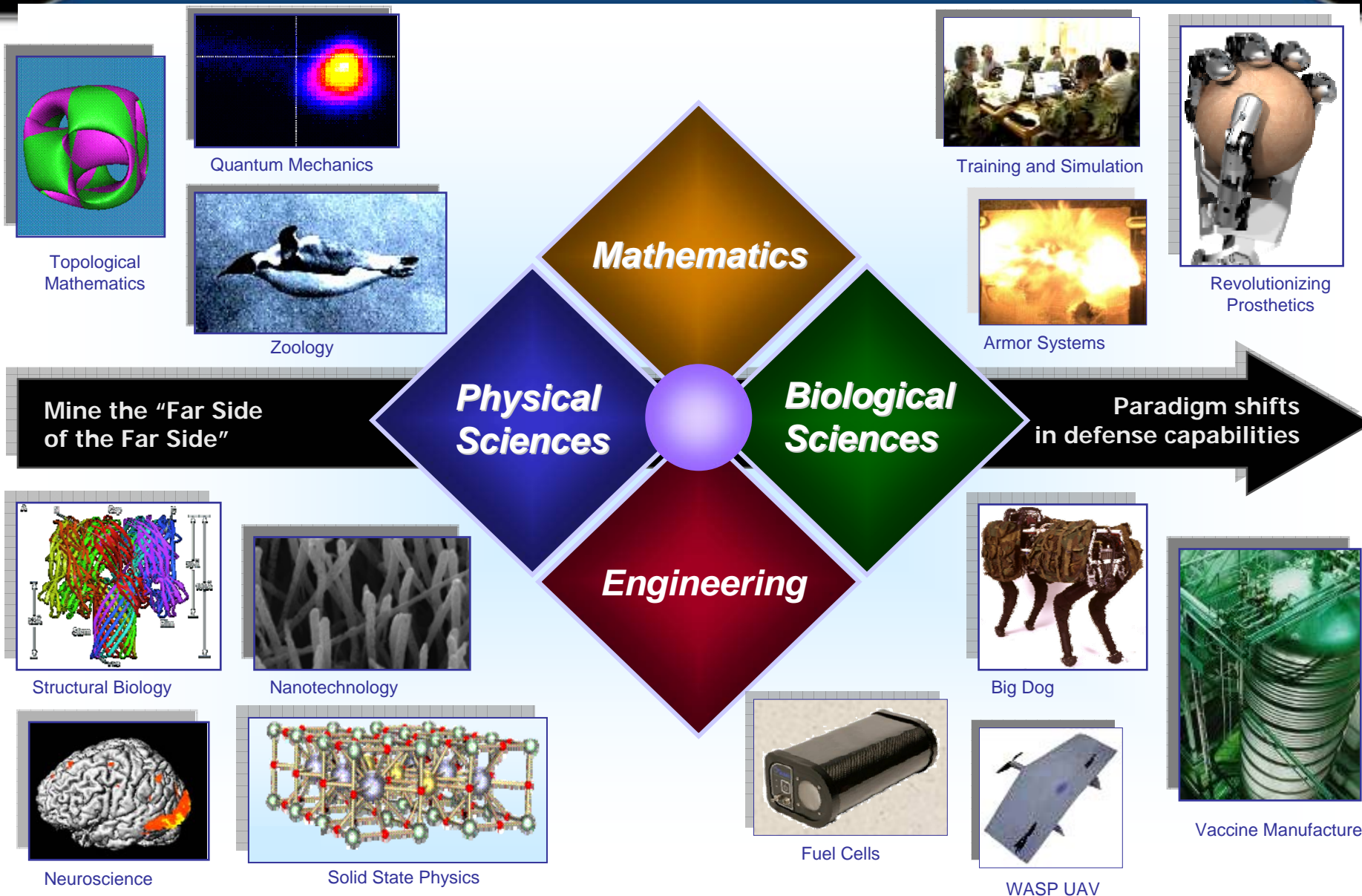
## Microsystems Technology

**Greg Kovacs**  
**Dean Collins**

- Electronics
- Photonics
- MEMS
- Algorithms
- Integrated Microsystems



# Defense Sciences Office



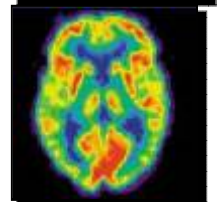




# Methods to Understand Neural Basis of Human Cognition



- Brain lesions and cognitive neuropsychology
- Electrophysiological recordings in primates (mammals)
- Pharmacological and genetic studies
- Transcranial magnetic stimulation
- Functional Neuroimaging
  - Hemodynamic-metabolic methods including PET/fMRI
  - Electric-magnetic methods including ERP and MEG




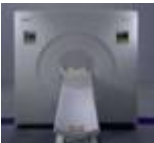



**Functional neuroimaging allows the activity of all brain regions to be seen simultaneously – true network analysis is possible**



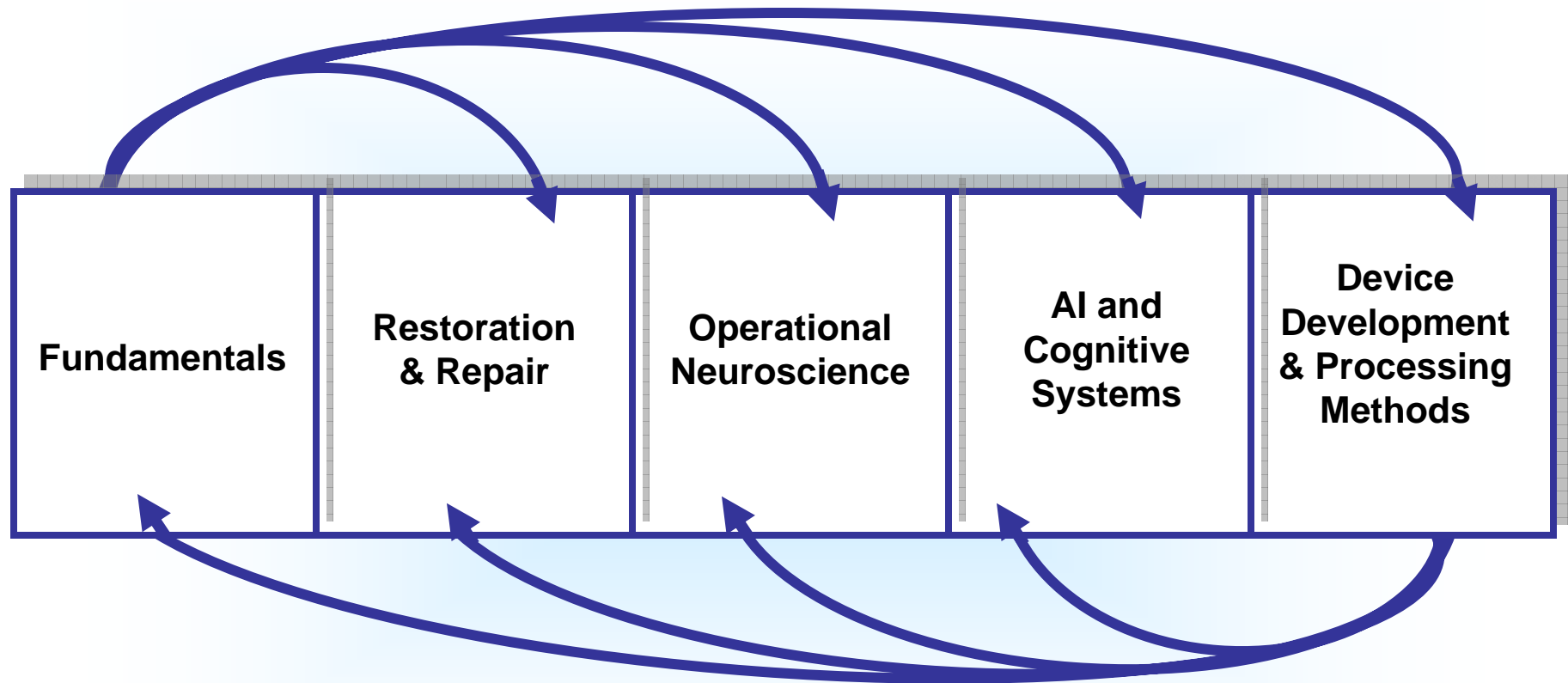
# Non-Invasive Sensor Technologies



Technology		Temporal Resolution	Latency	Spatial Resolution	Description	Operationally Feasible?
	EEG	ms	ms	cm	Measures electrical activity in the brain. Practical tool for applications - real time monitoring or brain-computer-interface.	Yes
	MEG	ms	ms	mm	Measures magnetic fields generated as a result of the brain's electrical activity. Research tool for investigating temporal properties of neuronal and cognitive processes.	No
	fMRI	s	min	mm	Measures the BOLD signal in neuronal tissue – oxygen uptake. Excellent structural localization of brain function. Important tool for foundational cognition research.	No
	PET	min	h	mm	Measures uptake of specially tagged molecules (e.g. glucose) in brain tissue following stimulus. Excellent spatial localization, poor temporally.	No
	fNIR	ms	ms	mm	Measures the ratio of oxygenation in cortical regions using near infrared light. Permits spatial and temporal measurements from the same volume of brain tissue.	Yes



# My Vision of Neuroscience





# Operational Neuroscience



**Brain activity can be monitored in real-time  
in operational environments with EEG**



**Desktop sleep deprivation  
assessment in desert stations**

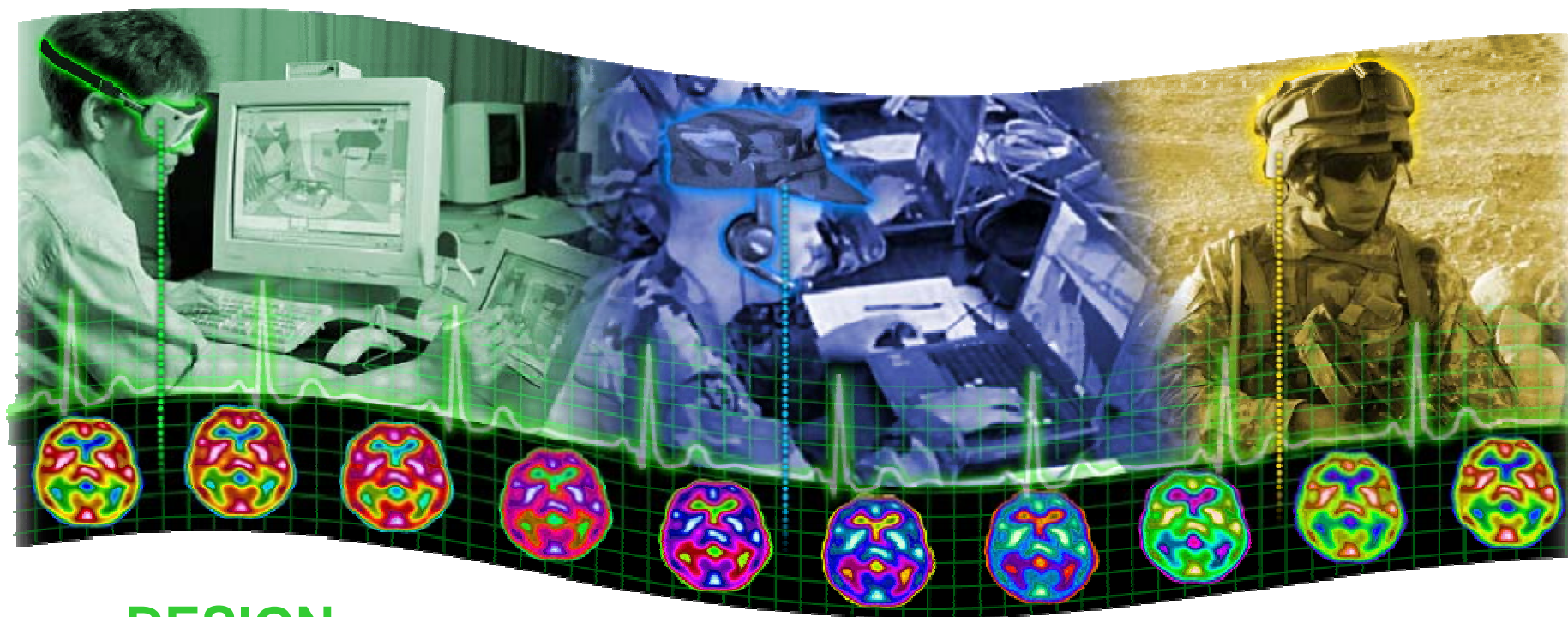


**Dismounted training exercises  
lasting 7+ hours at a time**





# Operational Neuroscience



DESIGN

TRAIN

OPS



**ACCELERATED LEARNING**



# Program Vision



- Utilize neuroscience to understand the development of expertise through learning
  - Use this understanding to directly facilitate and accelerate task learning for the warfighter
- 
- Learning is a continuous challenge in the operational environment
  - Current methods of learning fail to capitalize on basic lessons from neuroscience
  - Measures of learning on key skills only as good as qualitative and subjective assessments



**Using a neuroscience based approach, change the paradigm of learning in the military**



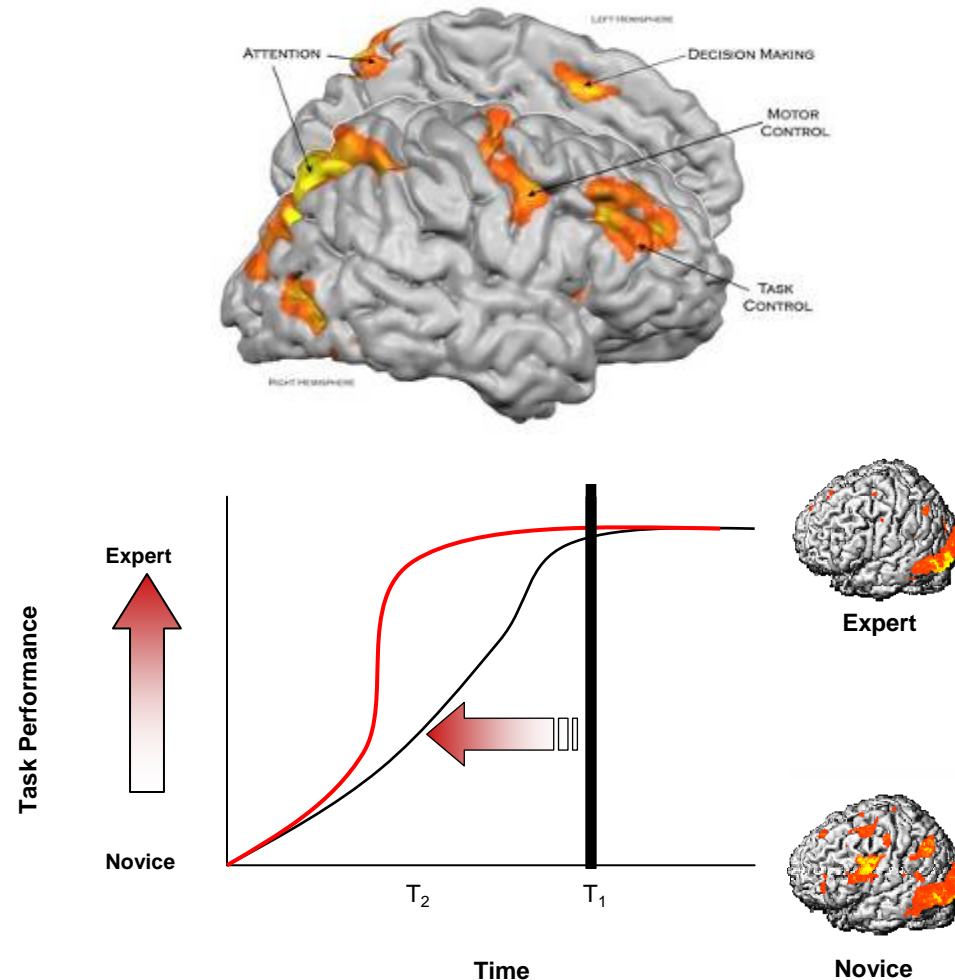
# Phase I Goals



Utilize neuroscience to understand the development of expertise through learning to directly facilitate and accelerate task learning for the warfighter

## Program Goals:

- Identify the neural basis of expert performance
- Track progression from novice to expert with classification of intermediary stages
- Demonstrate a two-fold increase in the progression between stages of the novice-to-expert path

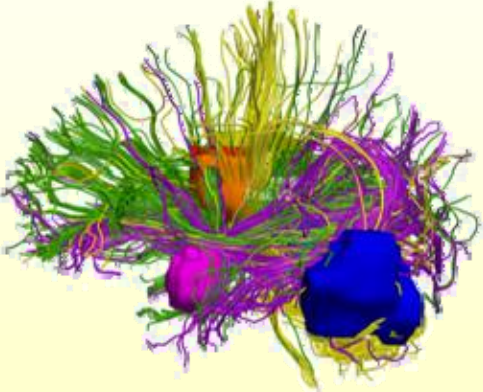
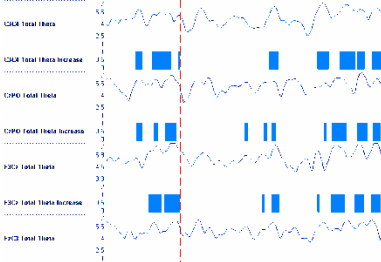
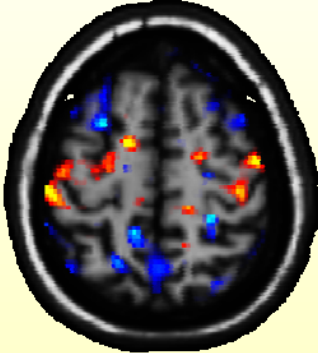







# Phase I Approaches



Optimized Task Qualities	Neurofeedback	Global Network Measures	Direct Stimulation
<ul style="list-style-type: none"><li>Apply multiple biological and cognitive findings about the user to customize the learning environment</li></ul> 	<ul style="list-style-type: none"><li>Present the user with real-time feedback on brainwave activity in the form of a haptic feedback during training</li></ul> 	<ul style="list-style-type: none"><li>Determine and facilitate the neural mechanisms of consolidation (declarative and procedural memory, attention networks, memory chunking)</li></ul> 	<ul style="list-style-type: none"><li>Utilize techniques such as tDCS in combination with functional imaging to directly stimulate neural pathways critical for learning</li></ul> 

Innovation

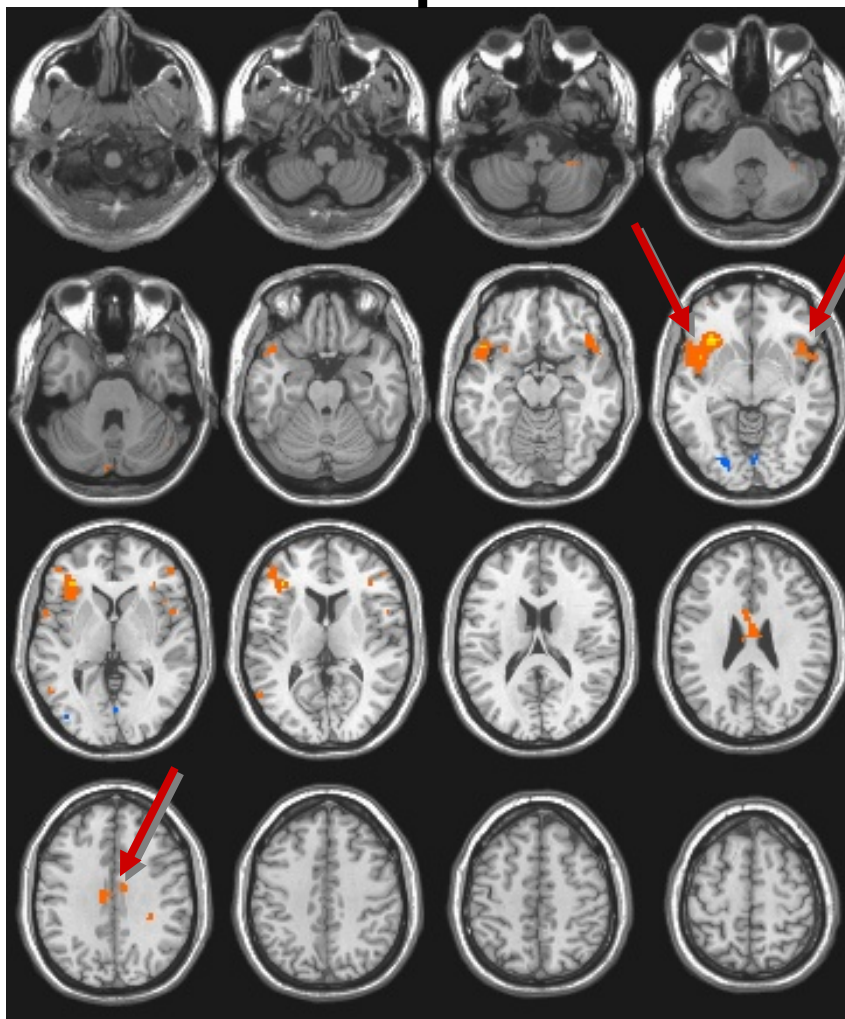
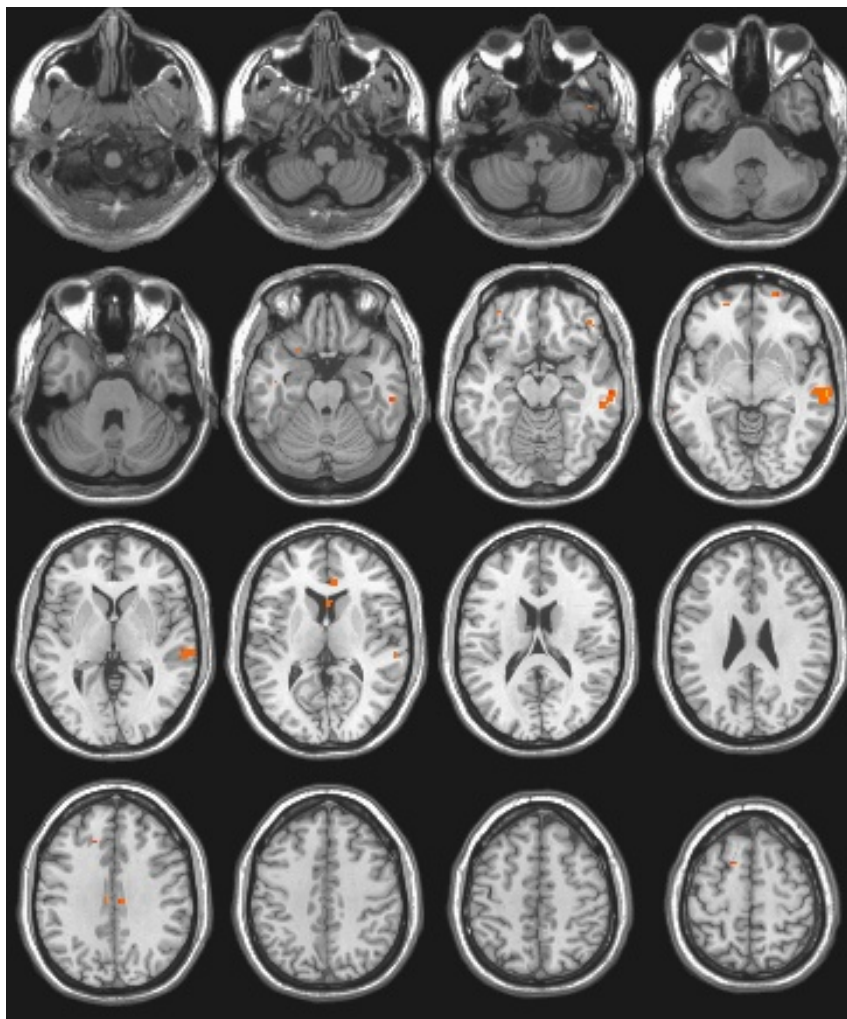


# Accomplishment: fMRI Signatures of Novice Vs. Expert Behavior



## Threat - Nonthreat Stimuli

<b>Novice</b>	<b>Expert</b>
---------------	---------------



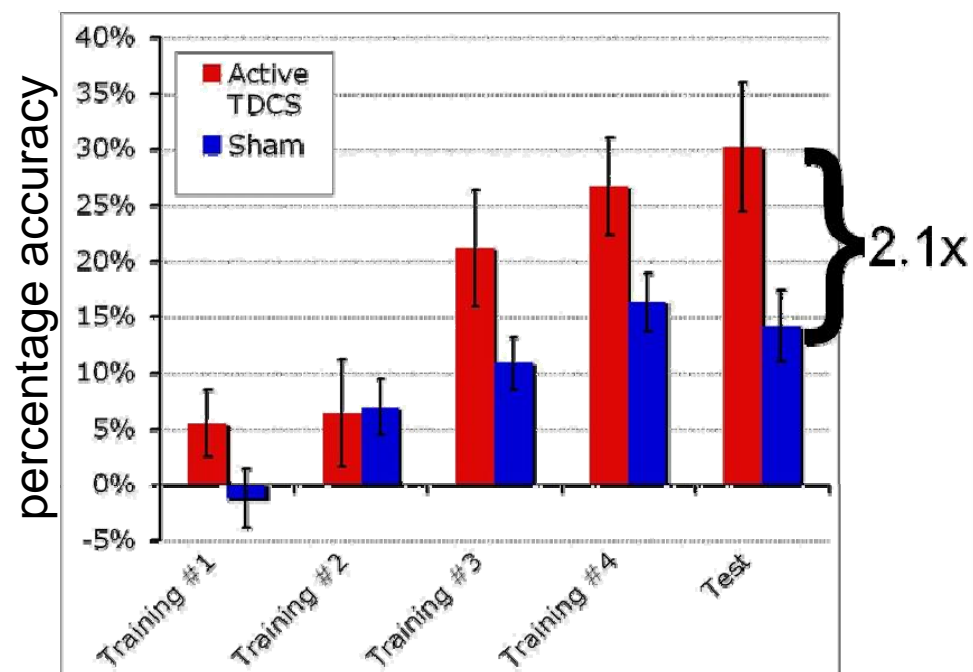


# Accomplishment: Direct Stimulation leads to 2x Improvement



**tDCS stimulation applied to the right sphenoid (right temple) at 2 milliamps for 30 minutes provides an improvement in learning vs. sham in threat detection training**

- 2.1x improvement ( $p=0.0093$ ) in threat and non-threat detection accuracy
- 3.1x improvement for threats alone ( $p=0.0004$ )









# Problem: Imagery Overload

## Operational Challenges

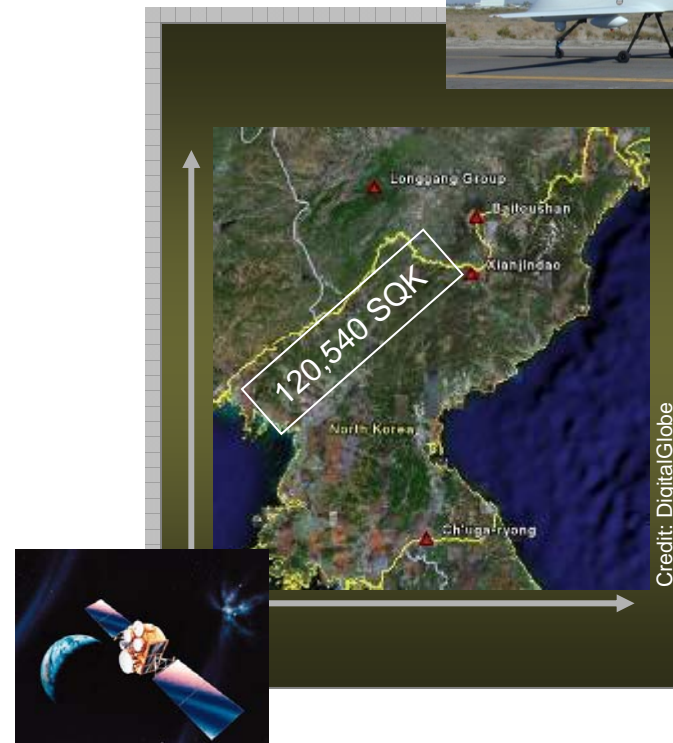
- Collections capabilities are increasing
  - Quantity
  - Modality
- Exploitation can require manual search through terabytes of overhead imagery

## Resources

- Current brute-force method (Broad Area Search) is time- and labor-intensive
- Machine vision and ATR have not matched the detection sensitivity and flexibility of the human visual system
- Exploitation requires manually searching through **terabytes** of overhead imagery



Credit: nps.navy.mil



Credit: schreiber.af.mil

**Result: Strategic analytical requirement exceeds available and foreseeable resources**

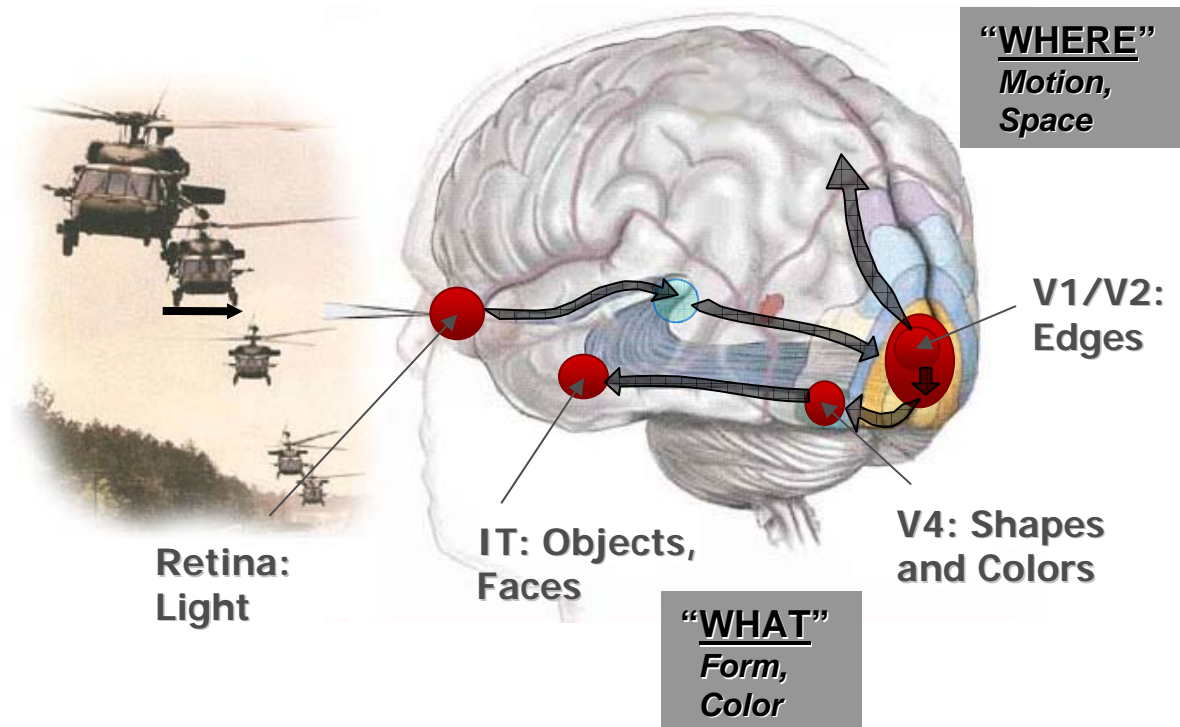


# One Solution: Leverage Human Perception



## Human vision is fast, accurate and robust to changes

- **Speed:** Earliest brain visual responses are <250 msec
- **Accuracy:** Human detection rate can be >>99%
- **Robustness:** Detection persists across a wide range of conditions



**NIA Solution: Brain-assisted exploitation – but how?**

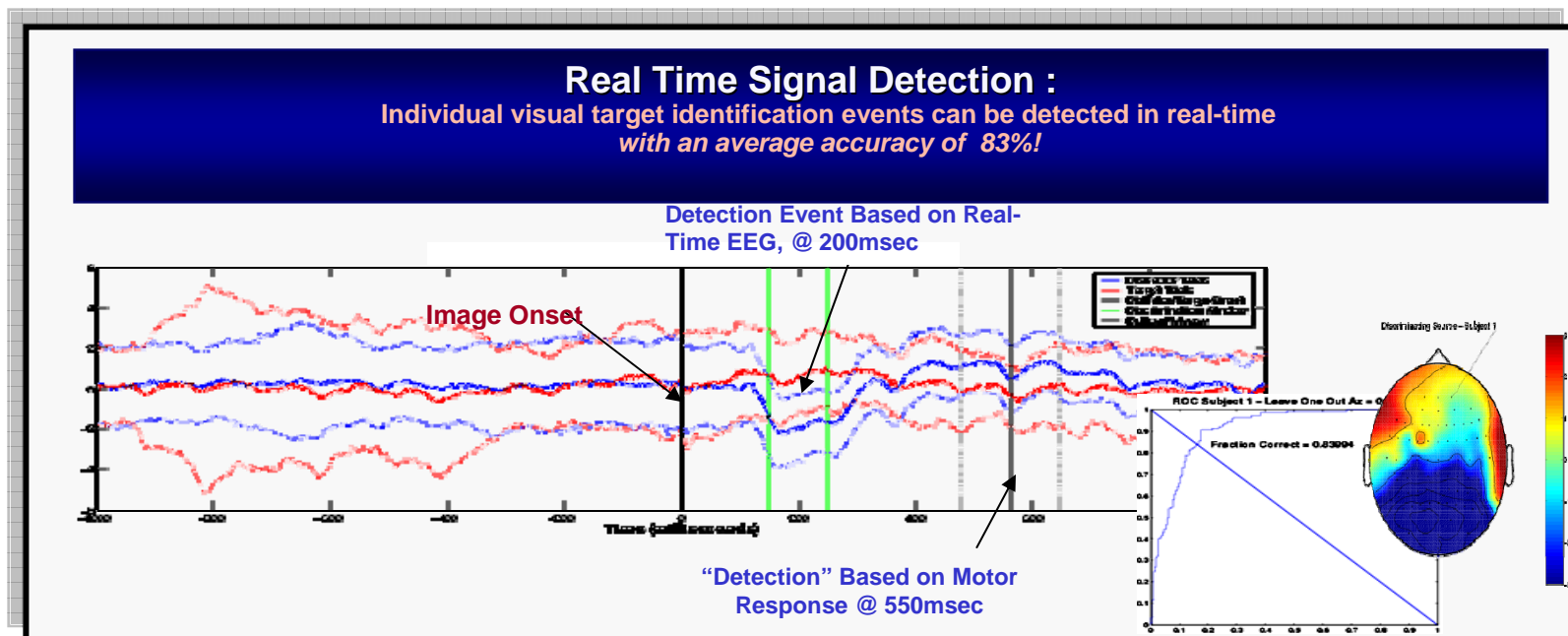


# Science Behind NIA



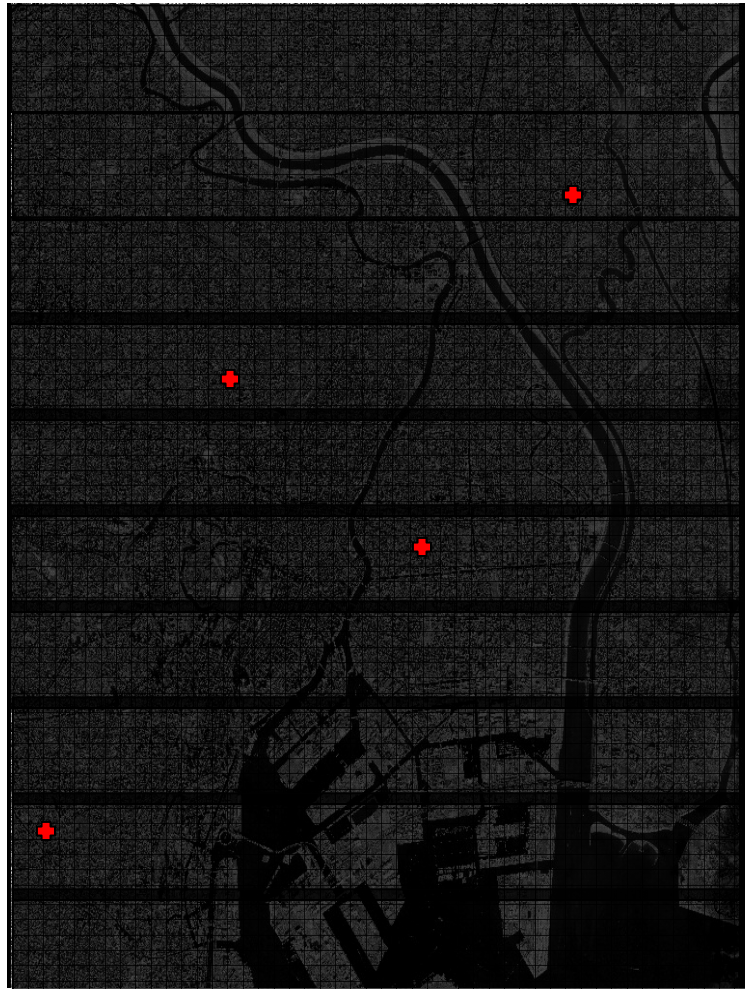
## Basic Science: Human visual detection events can be identified in EEG

- EEG signatures during Rapid Serial Visual Presentation
- Brain events can be detected in **one-third of the time** needed to press a button (Thorpe et al, Nature, 1996)
- Signature in neurophysiological recordings demonstrates detection of target images for presentation rates of up to 72 images/sec (Keysers et al, JCN, 2001)
- Demonstrated with faces, natural scenes, multiple presentations





# Experimental Approach: Baseline



➤  
+ = analyst indicated target during search

## Baseline (Broad Area Search) Task Example:

Total Area (urban, riverine, maritime) =  
314.86 km<sup>2</sup>

Targets: Helipads

Imagery Analysts were instructed to exploit the full scene manually in a geospatial software environment and to mark a defined target.

Exploitation was self-paced and analysts were allowed to search the image until satisfied all targets had been located.

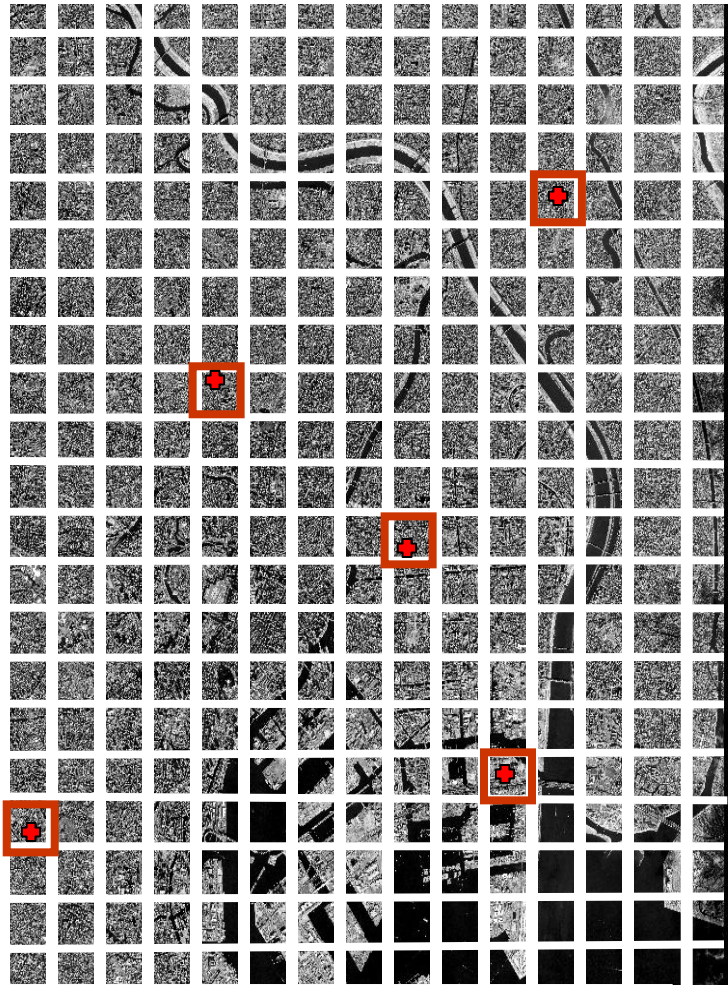
Analyst-marked target set was compared to ground truth (by 2 or more IAs) for sensitivity calculation.


**Estimated search time for trained IA:**  
**135 minutes**





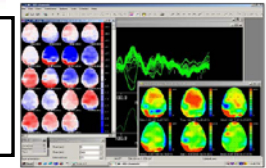
# Experimental Approach: NIA Triage



 = targets indicated via  
neural signals during triage



IA with neurophysiological  
sensors for image chip viewing  
(prototype display)

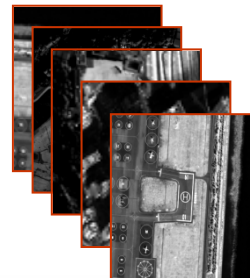


Full scenes were chipped into 512 pixels<sup>2</sup> (e.g.  
3300 chips for 314.86 km<sup>2</sup> total area)

Chips were at a magnification suitable for  
exploitation (1:1) but sized to minimize eye  
movements during triage

**All chips** were displayed rapidly (5-12 Hz) to IA.  
Neural signals were collected and classified in  
real time for target or non target properties

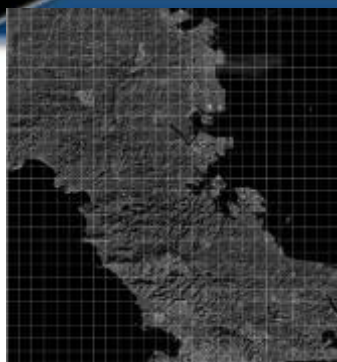
Triage mode time (10 Hz, including breaks):  
~10 minutes



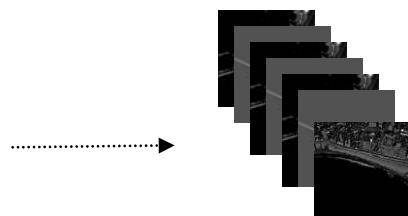
Chips with high target probability  
given by neural signal are marked  
and compared to truthed data for  
sensitivity assessment



# Phase I Results



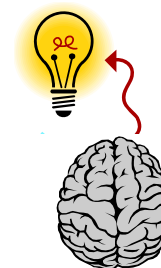
Original image tens of thousands of pixels wide and tall



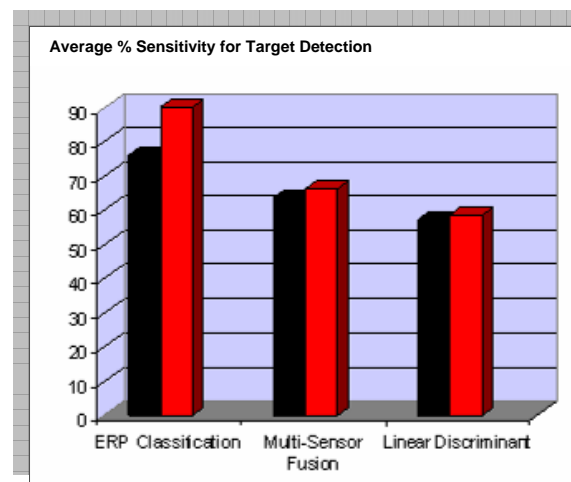
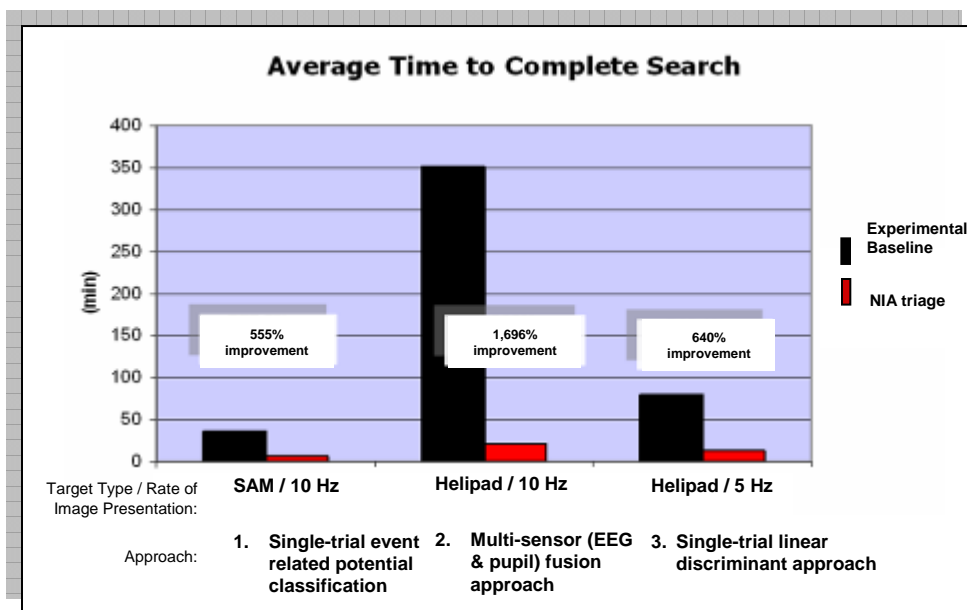
Decompose into chips few hundred pixels wide and tall



Present chips to users in high speed bursts (10 chips a second)



Evaluate neural activity to identify likely targets



**Result: >300% throughput improvement and detection equal or better than current SOA**



# NIA Phase 2 Vision



## Phase 2 Goal

Integrate modern neuroscientific techniques into imagery analysis workflow to improve throughput and quality of imagery analysis

## Phase 2 Metrics

- Maintain 300% throughput increase in imagery exploitation in a realistic analyst software/hardware environment.
- Demonstrate greater than or equal to unassisted image analyst sensitivity.
- Maintain performance across 3 complex target classes and under variable operating conditions.

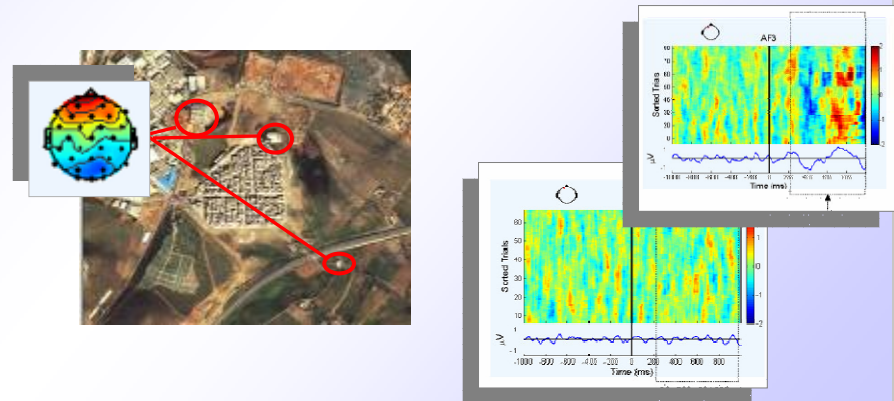
## Phase 2 Technical Challenges

- Capture brain signals in real time during realistic imagery analysis on baseline imagery exploitation systems
- Categorize target detection brain signals based on object / scene complexity
- Integrate neuromorphic computational image analysis and physiological brain signals

## Phase 2 Applied Science

*Apply Phase 1 breakthrough science in operational contexts*

- Extend capture of brain signals for target detection to:
  - Multiple imagery types
  - Diverse target and scene complexity
- Integrate brain-assisted search into standard imagery analysis software
- Leverage/converge with automated machine vision technologies
- Demonstrate with trained analysts with realistic tasks and environment

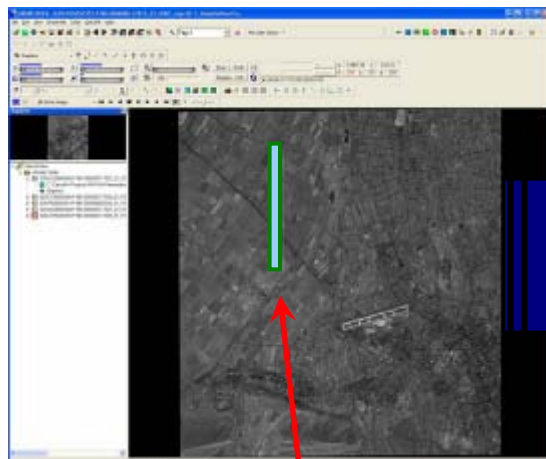




# Accomplishment: Remoteview Integration



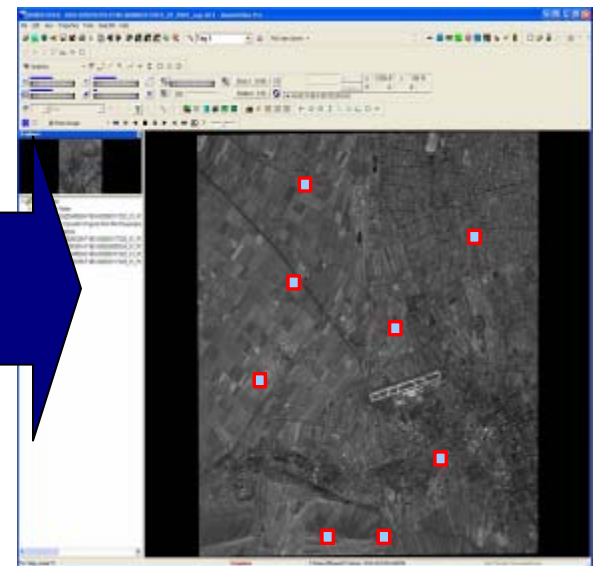
Triage integration approach maintains context before RSVP and during verification



Triage Preview



RSVP Triage



Post-Triage Review

Analysts maintain “global view” before triage begins, and can “fly to” any target hit results during post-triage exploitation

Credit: DigitalGlobe

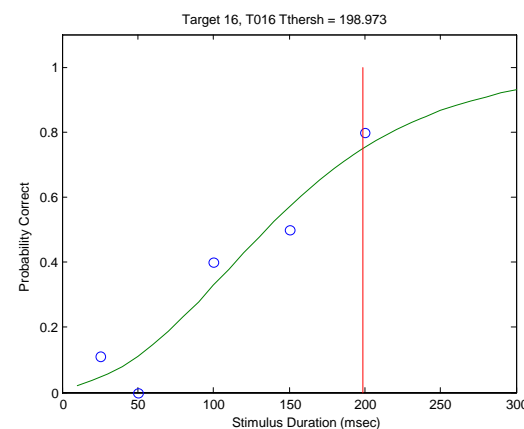
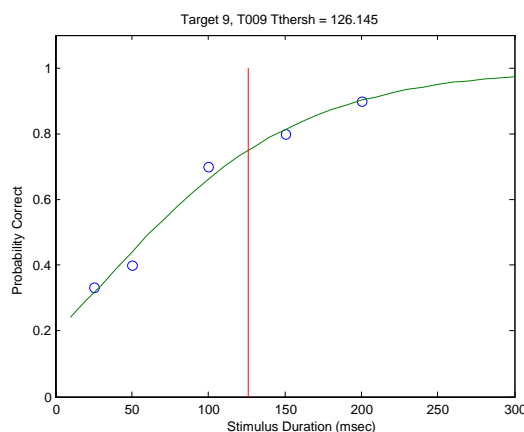
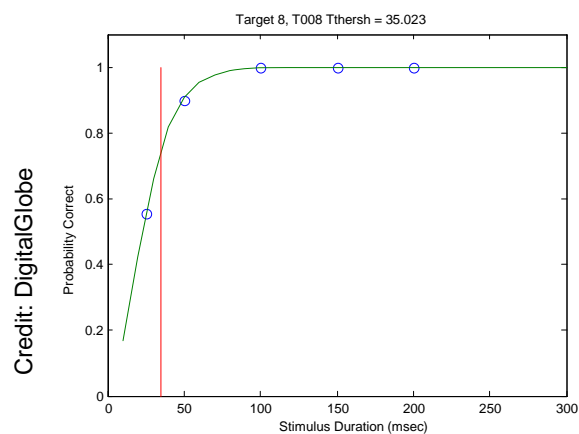




# Accomplishment: Uncovering impact of image complexity

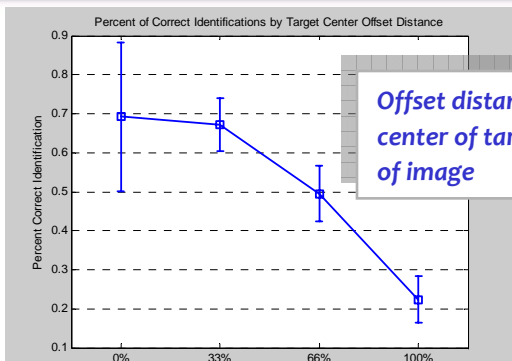


As targets become less stereotypical, the image stimulus duration necessary for correct detection increases



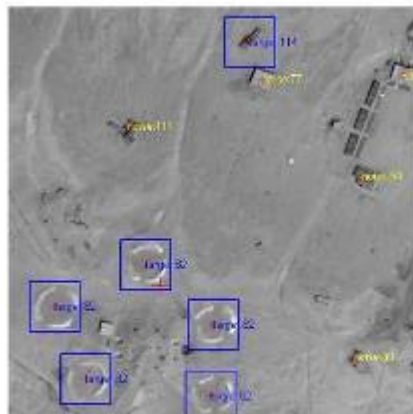


# Accomplishment: Computer vision enables target centering enhancing detection

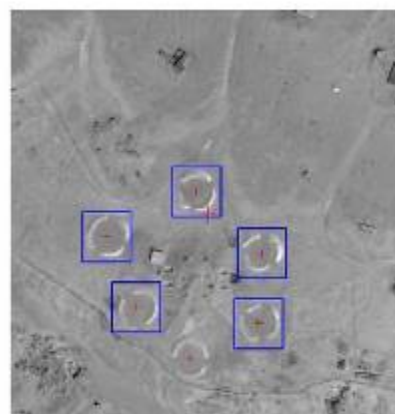


Offset distance from center of target to center of image

*Human detection performance is weaker when targets are off-center*



Result of default chipping



Result of computer vision aided chipping

- Computer vision techniques identify objects that share features with target of interest
- Small adjustments are made so that chipped images place **likely targets** at center of each chip
- Approach employed simple features (edges, intensity, spatial filter responses etc.) that are easy to implement and relevant across target types
- All targets in validation set were better centered

Credit: DigitalGlobe



# Examples of New Target Types



**Military Facility**



**Naval Order of Battle**



**POL Storage**



**Cargo Ships**



# CT2WS

## Cognitive Technology Threat Warning System





# Problem: Situational Awareness

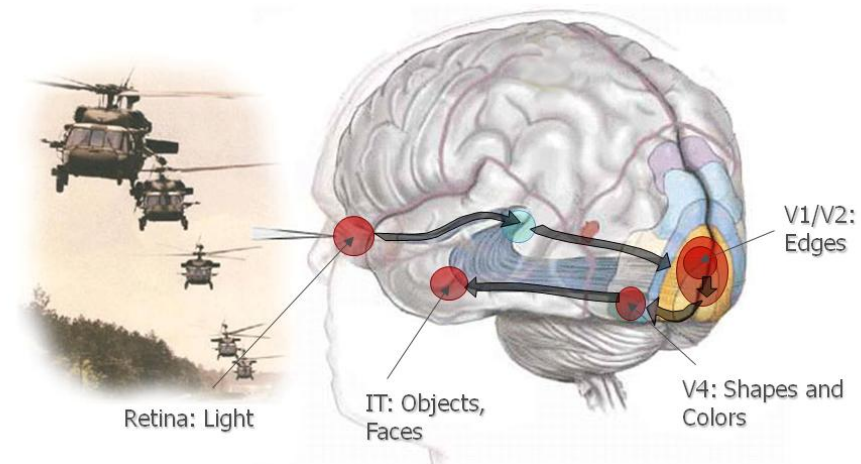


How can we take advantage of what we know about the mammalian visual system?

*Operational Need for Ground-Based Persistent Situational Awareness*



Current manual method is slow, imprecise and distance-limited



***Using visual science knowledge how can we provide a tactical advantage to the warfighter?***

- Visual Pathways
- Neural Signatures
- Object Recognition and Classification

**CT2WS aims to provide reliable early warning  
= More options, greater sphere of influence**



# Cognitive Technology Threat Warning System

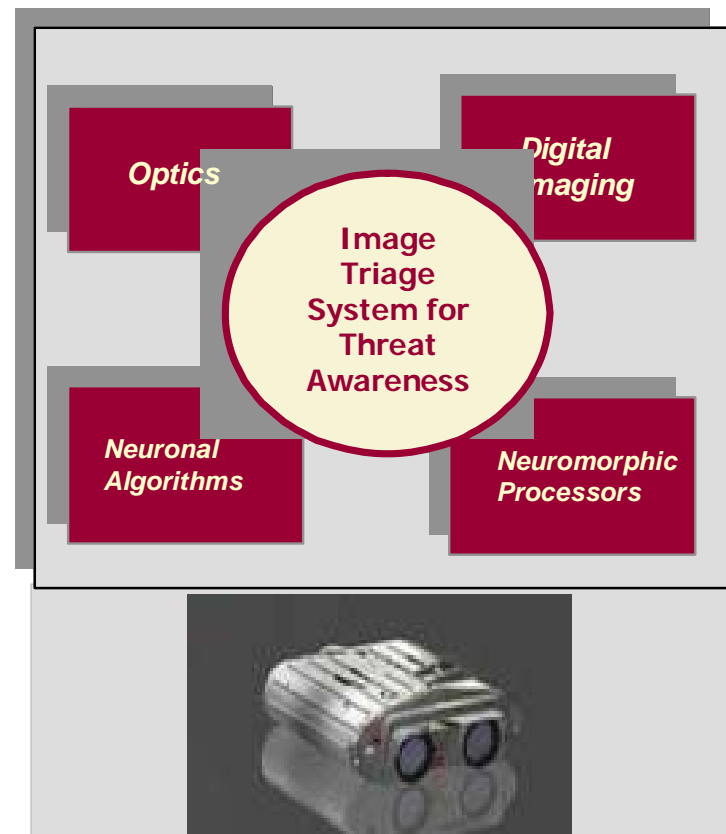
**Goal:** Tactical device which incorporates fusion of actual and simulated neural processing in real time to detect threats

**Current: 1000-2000 m**



**Current (M22): 9° 22'**

**CT2WS: 1000-10000 m**



**CT2WS: 120° FOV**



# CT2WS Objectives

## Detection Requirements

- Walking dismounts: 1 Km
- Stationary vehicles: 5 Km
- Moving vehicles: 10 Km
- FOV: 120°

## Technologies

- Optics: Flat-field, wide-angle
- Imagers: High pixel-count, digital
- Image Algorithms: Cognitive visual processing algorithms
- Neurally-based target detection signatures → Brain in the loop
- Electronics: Ultra-low power analog-digital hybrid signal processing



**Metric:**  $Pd \geq .98$ , False Alarm Rate  $< 10$  in less than 5 min.

Scene Triage: ***Objects of Interest*** rapidly detected and presented to operator for discrimination

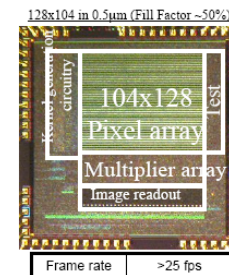




# Implementation Concept

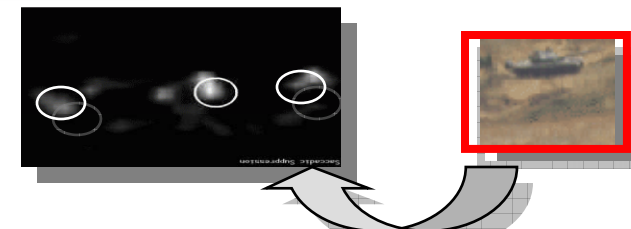
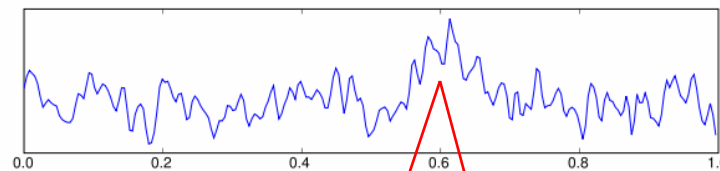


Cognitive algorithms scan ROI to give preliminary potential target information



Neuromorphic processors provide a platform for algorithms to run with maximum efficiency

EEG coupled technology rapidly presents potential targets to user allowing neural signal classification of target/nontarget



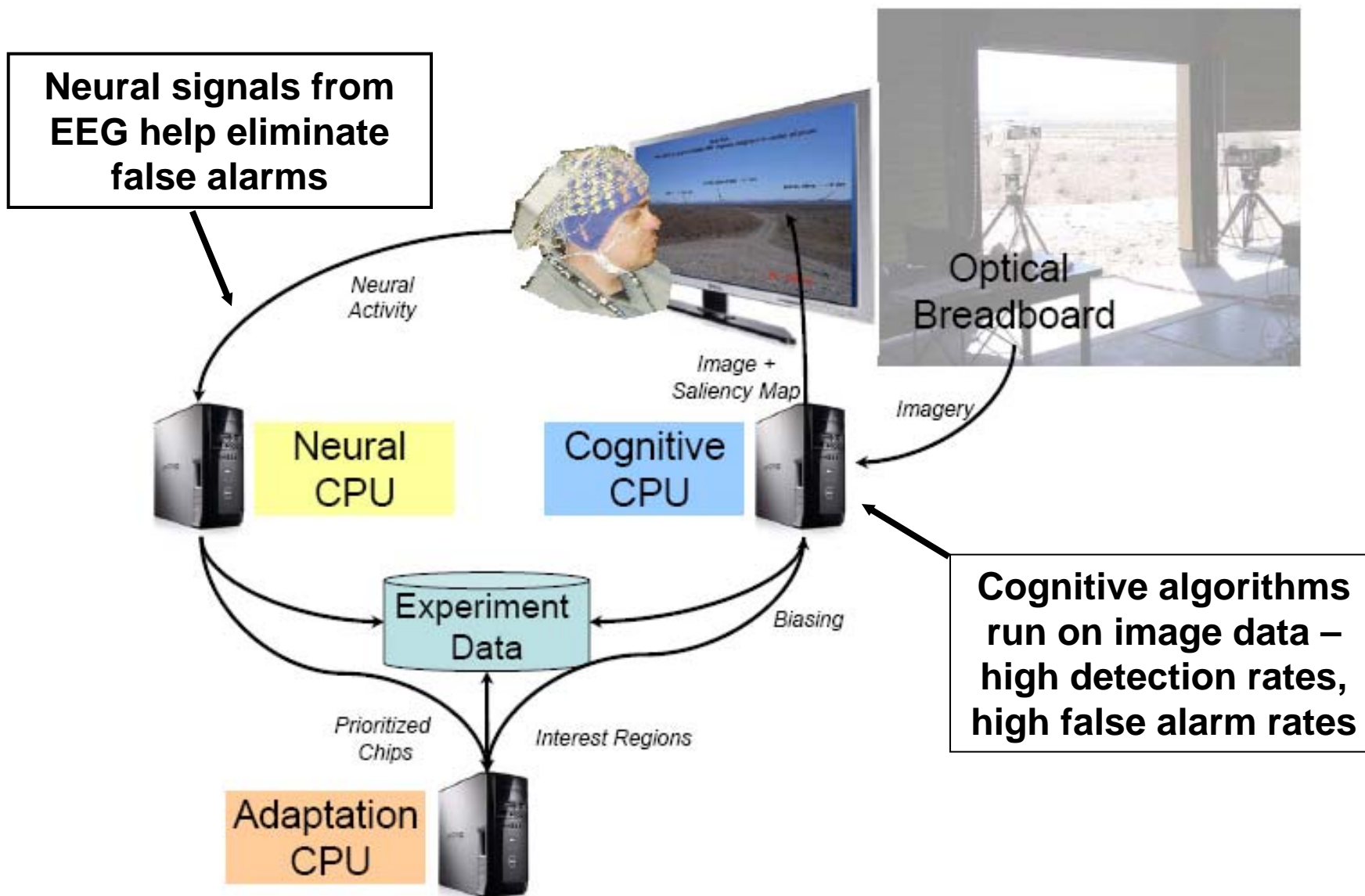
Algorithms can learn from the human, in real-time, to separate real targets from distractors, enhancing the overall utility of the system







# Field Test Breadboard Concept

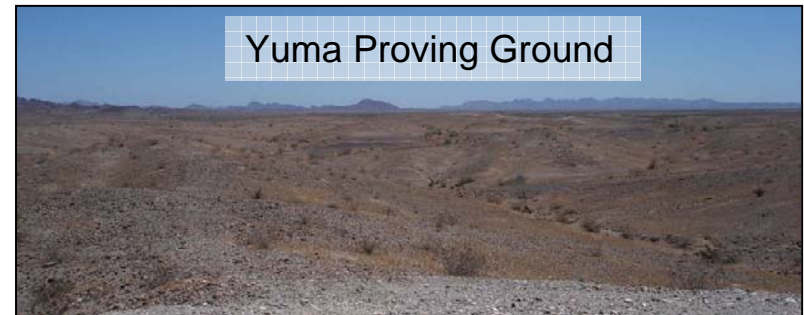




# Data Collection and Field Test Locations



- **Data Collected from Test Sites**
  - YPG
    - 87 hours of daytime data
    - 15 hours of nighttime data
  - Hawaii
    - 100 hours of daytime data
    - 12 hours of nighttime data
- **Current performers in the field THIS week testing initial systems components**





**Questions?**

**Ideas?**

**Where might you apply Neuroscience to  
future problems of interest to IC/DoD?**



# Intelligence Advanced Research Projects Activity (IARPA)

Dr. Lisa Porter  
Director, IARPA

5 November 2008

This briefing is UNCLASSIFIED





# Overview



I A R P A  
BE THE FUTURE

The IC needs a way to sponsor high-risk/high-payoff research that has the potential to provide the U.S. with an overwhelming intelligence advantage over our future adversaries

- This is about taking real risk.
  - This is NOT about “quick wins”, “low-hanging fruit”, “sure things”, etc.
- Failure is completely acceptable as long as ...
  - It is not due to failure to maintain technical and programmatic integrity
  - Results are fully documented
- Best and brightest.
  - Competitive awards and world-class PMs.
  - Every IARPA program will start with a good idea and a good person to lead it. Without both, IARPA will not start a program.
- Cross-community focus.
  - Address cross-agency challenges
  - Leverage agency expertise (both operational and R&D)
  - Work transition strategies and plans



# The “Heilmeier Questions”

1. What are you trying to do?
2. How does this get done at present? Who does it? What are the limitations of the present approaches?
  - Are you aware of the state-of-the-art and have you thoroughly thought through all the options?
3. What is new about your approach? Why do you think you can be successful at this time?
  - Given that you’ve provided clear answers to 1 & 2, have you created a compelling option?
  - What does first-order analysis of your approach reveal?
4. If you succeed, what difference will it make?
  - Why should we care?
5. How long will it take? How much will it cost? What are your mid-term and final exams?
  - What is your program plan? How will you measure progress? What are your milestones/metrics? What is your transition strategy?



# The “P” in IARPA is very important

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I A R P A  
BE THE FUTURE

- Technical and programmatic excellence are required
- Each Program will have a clearly defined and measurable end-goal, typically 3-5 years out.
  - Intermediate milestones to measure progress are also required
  - Every Program has a beginning and an end
  - A new program may be started that builds upon what has been accomplished in a previous program, but that new program must compete against all other new programs
- This approach, coupled with rotational PM positions, ensures that...
  - IARPA does not “institutionalize” programs
  - Fresh ideas and perspectives are always coming in
  - Status quo is always questioned
  - Only the best ideas are pursued, and only the best performers are funded.

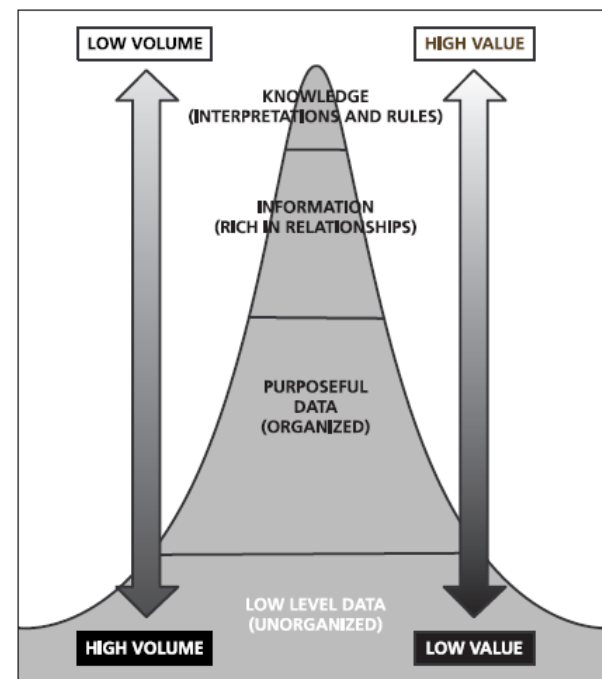


# The Three Strategic Thrusts (Offices)



IRAPA  
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- **Smart Collection:** dramatically improve the value of collected data
  - Innovative modeling and analysis approaches to identify where to look and what to collect
  - Novel approaches to access
- **Incisive Analysis:** maximizing insight from the information we collect, in a timely fashion
  - Advanced tools and techniques that can handle large volumes of multiple and disparate sources of information
  - Innovative approaches (e.g., using virtual worlds, shared workspaces) that dramatically improve the productivity of analysts
  - Methods that incorporate socio-cultural and linguistic factors into the analytic process
- **Safe and Secure Operations:** countering new capabilities of our adversaries that could threaten our ability to operate effectively in a networked world
  - Assure the confidentiality, integrity and availability of our cyber systems
  - Quantum information science and technology







# Concluding Thoughts

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I A R P A  
BE THE FUTURE

- Technical Excellence & Technical Truth
  - Scientific Method
  - Peer/independent review
  - Full and open competition
- We are looking for outstanding PMs.
- How to find out more about IARPA:

[www.iarpa.gov](http://www.iarpa.gov)



# **Building an Integrated Ground Architecture to Respond to Present Challenges**

**5 Nov 2008  
Pete Rustan**



# INTEGRATED GROUND ENTERPRISE

- **Vision**
  - *To implement a fully integrated Intelligence Community ground architecture where information is virtual, assured, available on demand, and globally accessible to authorized users empowered with the tools and services necessary to generate tailored, timely, trusted and actionable intelligence products.*
- **Mission**
  - *To develop, deliver, and sustain a responsive, secure, interoperable, and integrated ground architecture while collaboratively providing timely, value-added, trusted information to users worldwide through innovative solutions.*



# THE 1<sup>ST</sup> DECADE OF THE 21<sup>ST</sup> CENTURY

- The speed of change is phenomenal
  - In 2000 17 billion SMS messages were sent, in 2004 500 billion
  - In 1995 18,000 web sites, in 2007 106,875,138
  - In 1998 there were 0 Blackberries, in 2007 8,000,000
- Space can provide a great asymmetrical advantage
  - But the global economy and advances in space capabilities worldwide are leveling the playing field
- We must have
  - Speed (of thought as well as action)
  - Agility (no more stovepipes)
  - Scale (e.g. must be able to handle the torrent of text messages per day)



## Unpredictable Growth in Mobile Communications





# LIVING IN EXPONENTIAL TIMES

- U.S. is 20<sup>th</sup> in the world in broadband internet penetration
  - Just behind Luxembourg
- There are over 110 million MySpace users and 300,000 new users per day
- Over 2.7 billion Google searches each month
- Number of daily text messages exceeds the population of the planet
- 3<sup>rd</sup> generation fiber tested to 10 trillion bits/second on one fiber line
  - Equivalent to 1,900 CDs or 150 million phone calls every second
- 47 million laptops shipped worldwide in 2005

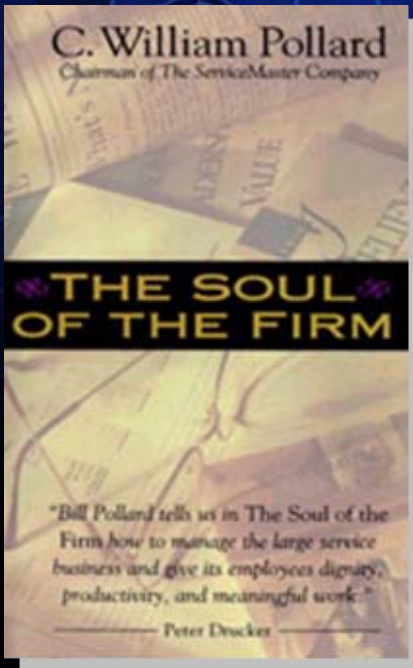
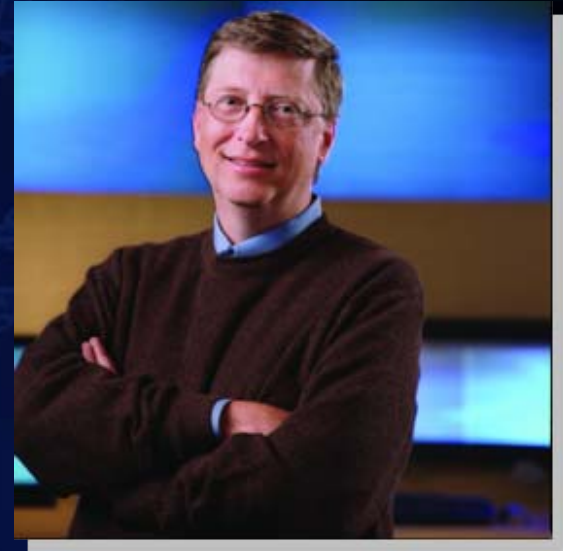
**IT Revolution has fundamentally changed everything we do**



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***“Never before in history has innovation offered promise of so much to so many in so short a time.”***

**- Bill Gates**



***“Learning and innovation go hand in hand. The arrogance of success is to think that what you did yesterday will be sufficient for tomorrow.”***

**- William Pollard**

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# (U) CUSTOMER NEEDS: ACCESS

## ***Need for Easy Access***

- Problem: Users require relevant data and information that is readily available. Common, user-friendly interfaces to obtain, understand, and use intelligence—regardless of its source or type—is critical to operational success
- Solution: Post all information products and services for easy access through a single portal to authorized users

***Desired Outcome: Users can access data any time, from anywhere***





# CUSTOMER NEEDS: CONTENT

## ***Need for Better Content***

- Problem: Users demand improved intelligence content, such as better geolocation, improved radiometric quality, and integrated data sources
- Solution: Improve the information derived from individual data types and fuse products from various collectors to provide a large number of new products and services

***Desired Outcome: Users receive new types of information products and services to generate actionable intelligence***





# CUSTOMER NEEDS: TIMELINESS

## *Need for More Timely Delivery*

- Problem: Users demand the information they want -- when they want it -- and have little patience for delays
- Solution: Emphasize real-time availability of all products and services

***Desired Outcome: Users get the information they need within their timelines***

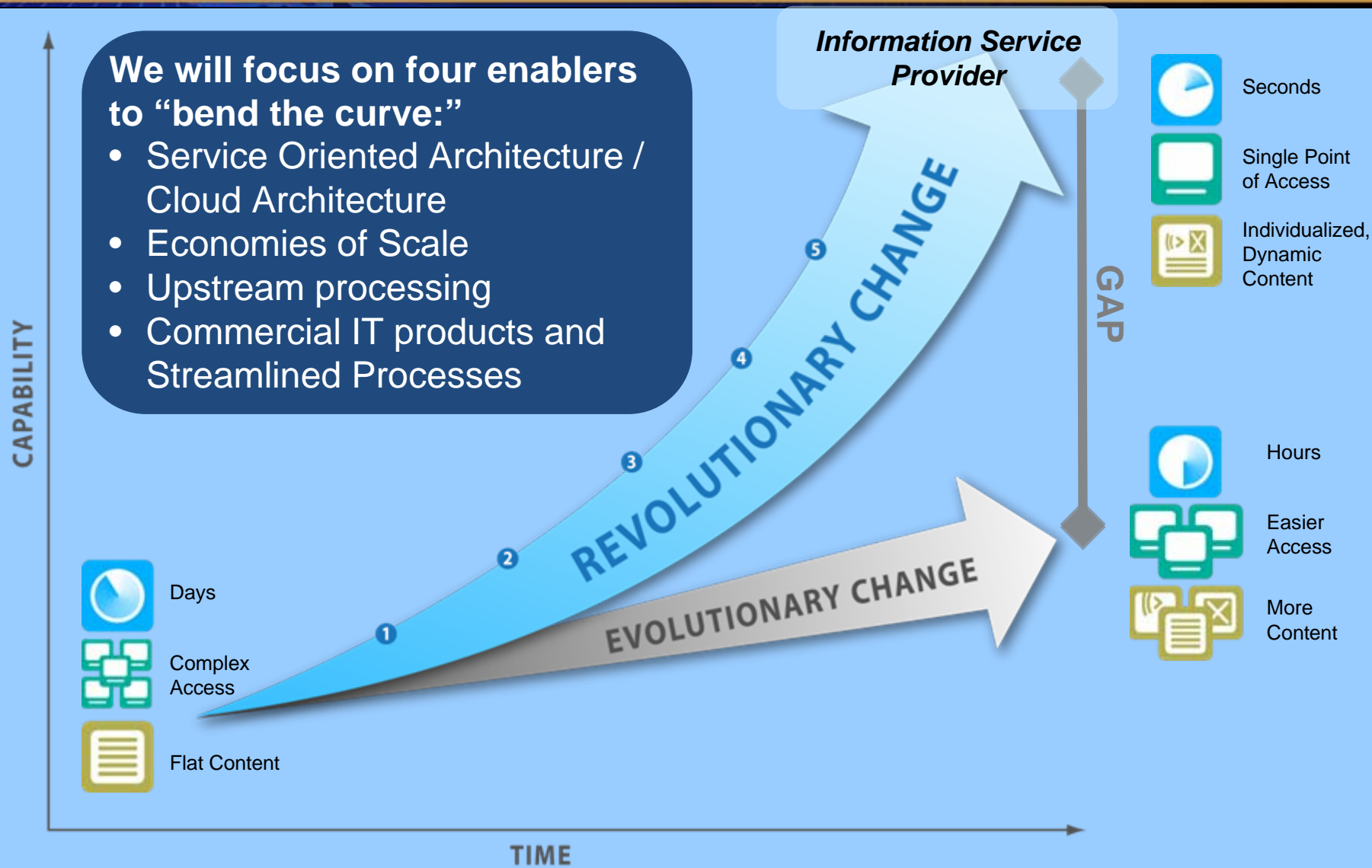


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# LINKING VISION TO PRODUCTS AND SERVICES

We will focus on four enablers to “bend the curve:”

- Service Oriented Architecture / Cloud Architecture
- Economies of Scale
- Upstream processing
- Commercial IT products and Streamlined Processes



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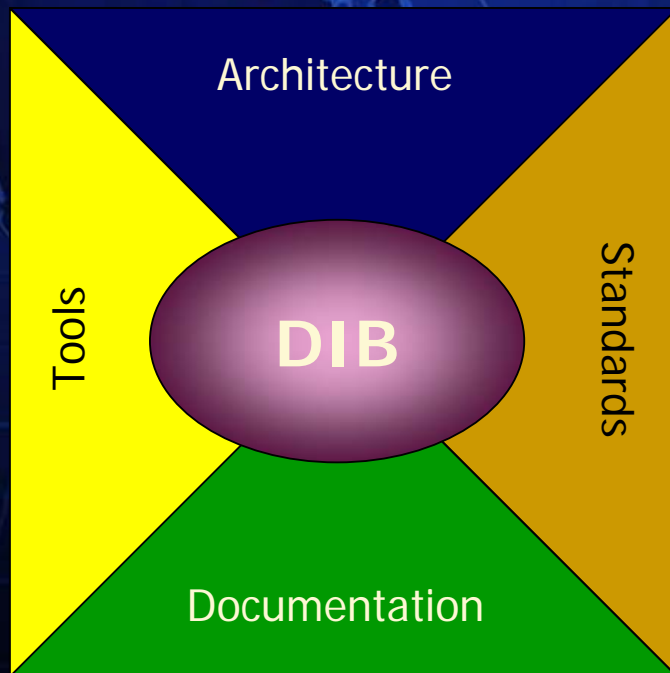
# SOA

- ***Open Standards.*** Our ground architecture will evolve away from customized solutions aimed at solving specific problems; we will adopt commercial open standards into our acquisition processes.
- ***Challenge: Interfacing with legacy systems.*** Our Ground SOA Framework will use adapters to convert legacy Application Program Interfaces (API) to SOA-compatible formats.

***Adoption of a SOA will allow for a persistent architecture where developers can bring content to the Intelligence, Surveillance and Reconnaissance (ISR) enterprise***



# IMPLEMENTING A SOA/CLOUD ARCHITECTURE COMPATIBLE WITH THE DCGS



- **DCGS Integration Backbone (DIB)**
- **Governance**
- **Common core services, infrastructure**
- **Re-use of Services**
- **Single query access to multi-INT**
- **Delivery of unique, net-enabled, value-added IC services**
- **Ubiquitous, common-standard visualization interface**
- **“Discoverable” data and services**
- **Global Situational Awareness**
- **Rapid acquisition and transition**
- **Use of “live/real” data for testing**





# UPSTREAM PROCESSING

- Integrate upstream overhead SIGINT and GEOINT processing
- Integrate tactical SIGINT data with overhead SIGINT
- Automate new upstream processing and fusion procedures
- Assist users to take full advantage of the fused upstream data products
- Provide analysts tools needed to convert manual exploitation into semi-automatic procedures
- Develop a process to support incremental delivery of upstream ground capabilities and the discovery process that is intrinsic in spiral development
- Employ common baseline of signal and data processing components that can be reused in upstream SIGINT and GEOINT applications
- Define standards to publish metadata to capture the result of GEOINT and SIGINT upstream processing and analysis
- Enable the exchange of GEOINT and SIGINT upstream signals by defining upstream signals data interfaces

***Take full advantage of commercial and government advances in automated target recognition and upstream processing to deliver information products and services in near real-time***



# CALL TO ACTION

**History does  
not crawl, it  
jumps**

**Implications  
for the IC**



**Understand our  
challenges**

**Convert these  
challenges into  
great opportunities**

## **Desired State**

**An Intelligence Community enterprise that operates as efficiently as the best commercial IT and knowledge service companies enabling authorized users to receive, task and query trusted information on-demand to improve the speed and execution of decisions from anywhere in the world.**